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Antral Gastritis: Roentgenologic and Gastroscopic Findings[1]

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PYLORIC AND prepyloric lesions can usually be recognized by present methods of x-ray study. Nevertheless, it is often as difficult to make a differential diagnosis of the detected or suspected gastric lesion as it might be of some obscure pulmonary pathological process. Carcinoma, benign ulcer, syphilis, hypertrophy of the pyloric muscle, and antral gastritis may at some particular phase of development so closely simulate one another that a differential diagnosis resolves itself into a matter of problematic enumeration based on the known percentage incidence of the respective lesions.

Morgagni (1) in about 1740 gave the first classical description of an erosive or ulcerating gastritis. He described some of the erosions as being gangrenous and stated that the process involved not only the stomach but extended down into the duodenum and jejunum. His conclusion that the ulcerations were due to something that the patient had eaten were probably not too erroneous, since patients who die of lysol poisoning within seventy-two hours after ingestion often present gastric and duodenal lesions closely simulating Morgagni's original description.

Rokitansky (2), in 1855, was the first to describe the mucosa of gastritis. The hypertrophy, nodular mucosal folds, and mucopurulent secretion which he pictured have been observed by every pathologist and gastroscopist in advanced hypertrophic gastritis. Rokitansky (2) concluded that this was most common in the antrum of the stomach, a conclusion that has been verified by numerous recent observers.

PATHOLOGY

According to Faber (3) gastritis is an inflammation of the gastric wall, of as yet unknown etiology, which begins in and may be limited to the mucosa, but which frequently extends to the deeper layers, even to the serosa. The disease may be generalized throughout the stomach but is often limited to or has its maximum effect in the antrum.

The gross pathological findings in antral gastritis may be divided into three groups:

(*1*) *An acute edematous process with involvement primarily of the mucosa and submucosa.* Gross examination reveals a brawny induration that closely simulates that of a malignant neoplasm. The mucosa is edematous and usually red. Edematous fluid oozes from the freshly resected specimen and there is marked retraction of the mucosa.

(*2*) *Ulceration of the mucosa with involvement of the muscularis submucosa.* Gross examination reveals an indefinite indura-

[1] From the Department of Radiology, Watts Hospital, Durham, N. C. Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.

tion with a moderate amount of thickening of the stomach wall. The mucosa is reddened, slightly edematous, and thickened. There are usually multiple superficial, sharply demarcated ulcers varying from 1 to 4 mm. in diameter. These ulcers may be covered with mucoid and mucopurulent secretion. They frequently show evidence of recent hemorrhage, and their borders often show some granulation tissue that may, when seen through the gastroscope, simulate malignant lymphoma.

(3) *A chronic inflammatory process with hypertrophy of the mucosa and round-cell infiltration of the muscularis submucosa extending down to the serosa.* Gross examination shows definite infiltration and thickening of the entire stomach wall closely resembling the infiltration of a malignant growth. The mucosa is firmly adherent to the underlying submucosa as a result of the long-standing inflammatory process. The mucosal folds are greatly thickened and beaded, presenting a wart-like surface. Superficial ulcerations are infrequent but may occur.

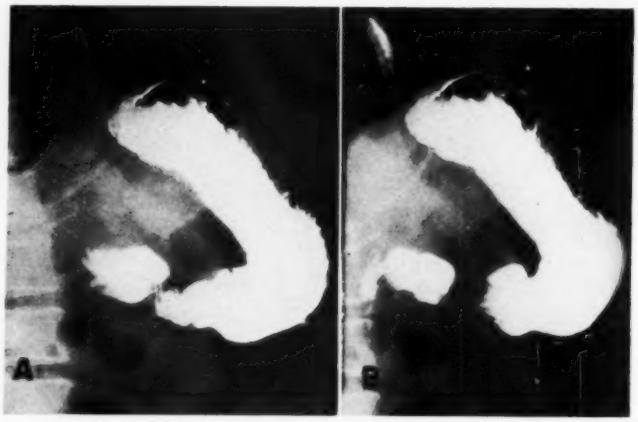


Fig. 1. Normal stomach showing antral systole as described by Golden (4). Note criss-cross of folds in the first roentgenogram (A) and smooth straight folds in the second (B).

PERISTALSIS AND MOTILITY OF THE MUCOUS MEMBRANE

Any pathological infiltration of the gastric mucosa, submucosa, or gastric wall will produce some change in the mechanism of peristalsis. The degree of aberration will depend upon the location, extent, and type of lesion. Since the antrum is the most important part of the stomach so far as motility is concerned, it is obvious that antral lesions will produce the greatest changes in motility.

The observations of Golden (4) on the gastric mucous membrane and antral systole are doubtless among the greatest contributions that have been made for both the roentgenologist and gastroscopist in the study of early antral lesions. I quote:

"As the narrow peristaltic wave enters the antral region, its relaxing edge decreases and its contracting edge increases in speed, closing off a portion of the lower end of the stomach and under normal conditions resulting usually in the expulsion of gastric contents. Then the wall relaxes promptly, and the lumen returns to its normal width and contour. This is known as the antral systole. Observations on a dog's stomach made in this department after the placing of opaque markers beneath the serosa suggest that the antral systole is associated with a contraction of the longitudinal muscle toward the pylorus.

"The normal mucous membrane of the stomach is freely movable over the muscle. This is easily demonstrated by palpation of a fresh specimen, by the separation of the

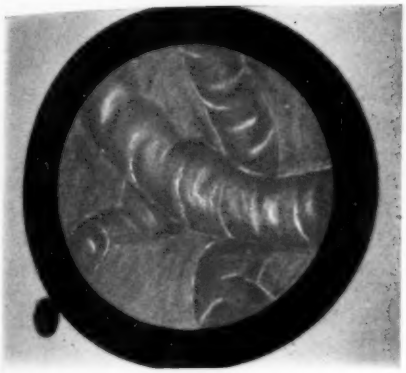


Fig. 2. Case II. July 14, 1943. Gastroscopic examination shows marked edema of the antral mucosa. No ulcerations noted.

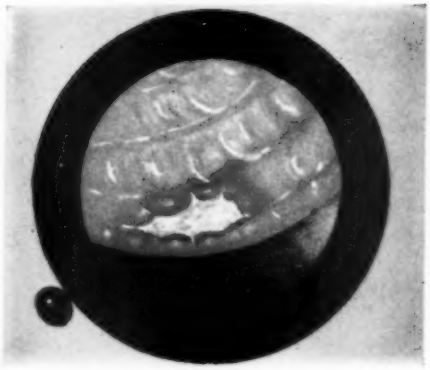


Fig. 3. Case III. March 21, 1944. Gastroscopic examination shows edema, reddening, and superficial ulceration of the antral mucosa.

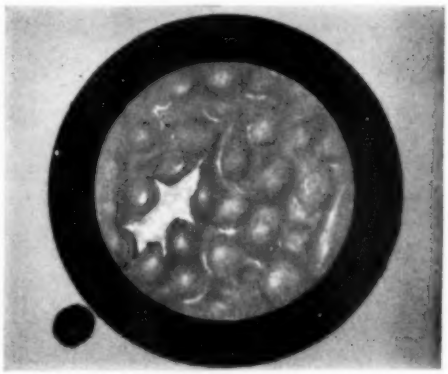


Fig. 4. Case IV. Sept. 25, 1943. Gastroscopic examination shows thickened and nodular gastric mucosa with one superficial ulcer; interpreted as either malignant lymphoma or hypertrophic gastritis.

mucosa from muscle wall when the stomach is opened at necropsy and by the projection of the mucous membrane over the edge of the muscle when the living stomach is cut at operation. Forssell (5) has shown that the formation of mucosal folds is the result of independent contraction of the muscularis mucosae. Obviously this independent movement is contingent on the mobility of the mucous membrane and intact muscularis mucosae. In some cases the mucosal folds in the antrum run irregularly transverse to the long axis of the stomach, and when the antral systole takes place they appear to change direction and run neatly parallel with the long axis. I have observed this phenomenon in the dog's stomach as well as the human stomach. (It is more easily seen in the small intestine.) For this change to occur, a movement of the mucous membrane in a cephalad direction must take place, thereby stretching it tightly beneath the muscular contractions. Otherwise, as the antrum closes off, the crisscross folds will be exaggerated, pushed down in a caudal direction and jammed toward the pylorus" (Fig. 1).

In correlating the roentgenologic, gastroscopic, and pathological findings in 576 patients studied gastroscopically, I have found the antral systole and motility of the mucous membrane as described by Golden (4) to be the most accurate and valuable roentgenologic and gastroscopic observation in detecting early pathologic changes in antral gastritis. Enlarged mucosal folds are apparently of no significance unless ulceration can be demonstrated.

SYMPTOMS

The clinical symptoms of antral gastritis may simulate either a benign or malignant ulcer, as demonstrated in the four cases presented in this discussion. The most characteristic clinical findings are epigastric pain, which is usually made worse by food; nausea, especially in the morning; weight loss, and occasionally gastric hemorrhage. Benedict (6) reported seven deaths from gastric hemorrhage due to gastritis.

Many observers believe that the pain associated with antral gastritis may be accounted for by the inflammatory infiltration in and around the sympathetic ganglia of the stomach. This was first suggested by Holsti (7). The weight loss, which may be as great as that noted in advanced malignant growth, is probably due to an impaired appetite and to limitation of food intake because of the associated pain.

ROENTGEN FINDINGS

The roentgen findings vary all the way from a temporary and persistent spasm of the antrum, with impaired, irregular, and ineffective peristaltic waves producing abnormal antral systole, to a constant filling defect such as may be seen in an antral or prepyloric carcinoma. If the lumen of the antrum is still patent so that a small amount of barium can be forced through, ulceration can frequently be demonstrated.

GASTROSCOPIC FINDINGS

The gastroscopic picture in antral gastritis depends entirely upon which one of the three pathological groups is represented by the case. Group 1 (Cases I and II) shows considerable reddening of the mucous membrane (Fig. 2), which is extremely edematous and closely simulates the oral mucosa following injection with novocaine. The antral channel may be completely occluded. Unless the pyloric sphincter can be well visualized, one can never be sure whether or not there is an underlying ulcer. Ulceration, however, is not common in this group. Group 2 (Case III) shows a red, rather edematous mucosa (Fig. 3). There are a number of superficial ulcerations from which bleeding is frequently seen through the gastroscope. There is usually a great abundance of mucopurulent material. In Group 3 (Case IV) the gastric mucosa has a cobble-stone appearance and is frequently rather pallid (Fig. 4). The mucosal folds are hypertrophied and appear beaded or wart-like. Ulcerations may occur but are infrequent. The normal shortening of the antrum associated with peristaltic waves is absent. The incisura

angularis and pyloric sphincter appear to be fixed in position.

PROGNOSIS

The prognosis in antral gastritis is apparently quite good, although gastric resection may be necessary. Not a sufficient number of cases have been followed over a long period of time to determine the incidence of gastric cancer arising on a chronic inflammatory process. Feldman (8) reported 3 cases with cancer developing during intervals of three, six, and seventeen years. Repeated x-ray examinations had been most suggestive of an antral gastritis. Gastroscopy was not done in these cases.

CASE REPORTS

CASE I: J. S. P., white male, age 50, admitted Nov. 23, 1939.

Chief Complaints: Epigastric pain, nausea, vomiting, and loss of weight.

Family History: Irrelevant.

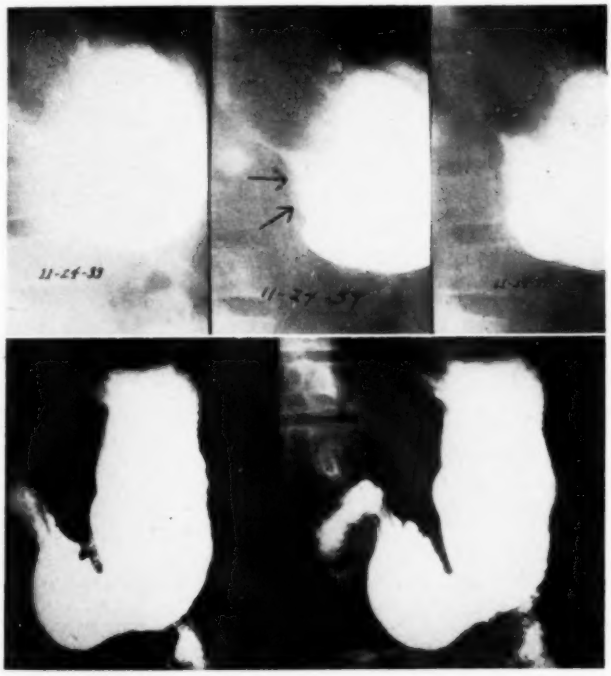
Past History: When in the hospital six months previously for cervical arthritis, the patient had some epigastric discomfort. X-ray examination of the stomach revealed moderate antral spasm but no definite lesion. Gastric analysis: no free HCl; total acidity 20°; occult blood positive. Blood count normal.

Present Illness: Onset one week prior to admission with rather severe but intermittent epigastric pain. The pain was constant in location. It was at first relieved by milk or food but later was made worse. There had been a loss of weight of 10 pounds since the previous admission.

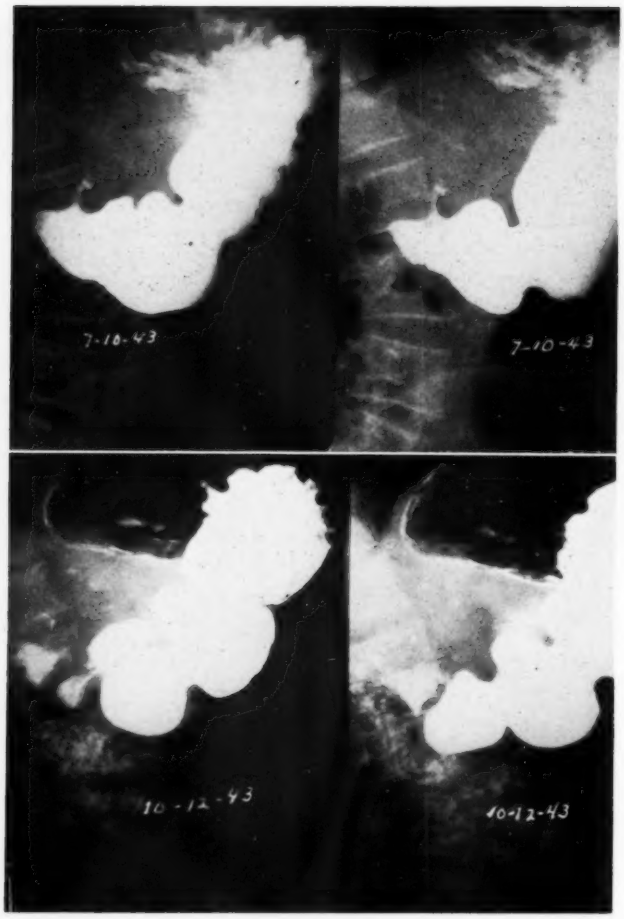
Physical Examination: The patient was well developed and fairly well nourished, not acutely ill. Examination was negative except for tenderness in the epigastrium. No masses were palpable.

Laboratory Studies: Complete blood count 5,200,000; Hgb. 110 per cent; white cells 5,850. Gastric analysis: free HCl 0; total acidity 15°.

X-Ray Examination: On Nov. 24, 1939, a filling defect involving the greater curvature in the prepyloric region was demonstrated, the appearance being most suggestive of carcinoma (Fig. 5). On June 10, 1941, the stomach appeared normal (Fig. 6).



Figs. 5 and 6. Case I. Roentgenograms made Nov. 24, 1939, show a large filling defect in the prepyloric region on the greater curvature. This was interpreted as carcinoma. The two lower roentgenograms, made June 10, 1941, show a normal stomach.



Figs. 7 and 8. Case II. Roentgenograms made July 10, 1943, show partial pyloric obstruction with an antral filling defect. There was a 60 per cent six-hour residue. The picture was interpreted as probably representing a malignant neoplasm. Roentgenograms made Oct. 12, 1943, show a normal stomach. The patient was then symptom-free.

Clinical Course: This patient was discharged Nov. 27, 1939, to arrange certain business matters and was readmitted Dec. 15, 1939, for partial gastrectomy. X-ray examination Dec. 16, 1939, showed the lesion previously described to have almost entirely cleared. Operation was postponed. The stomach was re-examined Dec. 27, 1939, and found to be essentially normal except for a slight antral spasm. At the last x-ray examination, June 10, 1941, the stomach was considered entirely normal.

The patient died Feb. 22, 1943, of coronary occlusion. Autopsy was not obtained.

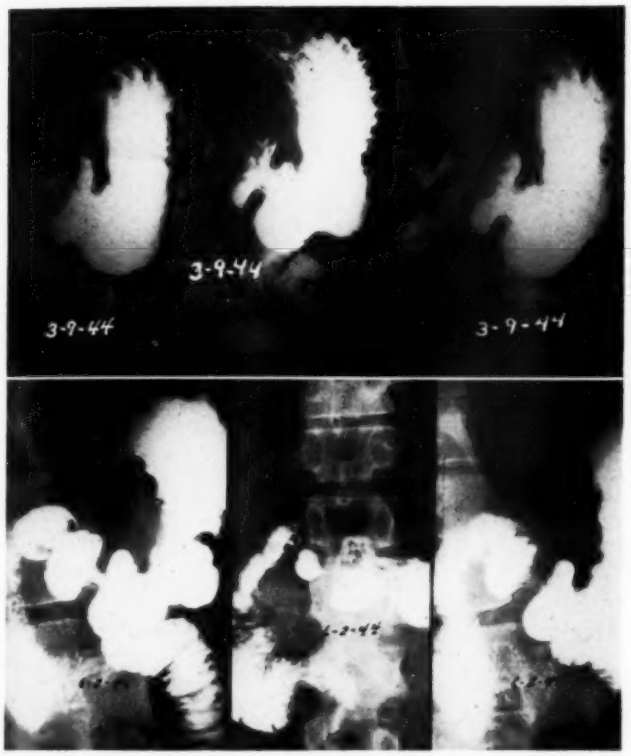
Comment: This patient probably had an acute edematous localized gastritis which cleared entirely under a medical régime. It is to be noted that there was a complete absence of free hydrochloric acid at all examinations.

CASE II: W. B., white male, age 59, admitted July 9, 1943.

Chief Complaints: Pain in the stomach, weakness, and lumbago.

Family History: One brother and one son had stomach ulcers. Father died of cancer of prostate; mother of coronary thrombosis.

Past History: The patient gave a history of duodenal ulcer since 1918, having followed a modified diet during the interval. He experienced an exacerbation nearly every Spring, characterized by fairly typical ulcer symptoms. Pain had always been re-



Figs. 9 and 10. Case III. Roentgenograms made on March 9, 1944, show a marked and persistent spasm of the antrum. The mucosal folds are irregular and thickened; the duodenal cap is deformed but no ulcer crater is demonstrated. The interpretation was probable antral gastritis.

Roentgenograms made June 2, 1944, show great improvement in the appearance of the antrum. Only slight spasm is observed. Antral systole was slightly prolonged.

lieved by soda and milk until the present illness. There had been occasional nausea and vomiting.

Present Illness: The patient had not felt up to par for the past two months and had gradually lost his appetite. There had been a loss of about 12 pounds in weight. Three weeks before admission an attack of severe epigastric pain occurred, followed by nausea and vomiting. This was not relieved by alkalis. The pain persisted but to a lesser degree. It was described as a constant burning in the epigastrium.

Physical Examination: Blood pressure 188/100. Moderate arteriosclerosis. Marked tenderness in epigastrium. No palpable masses.

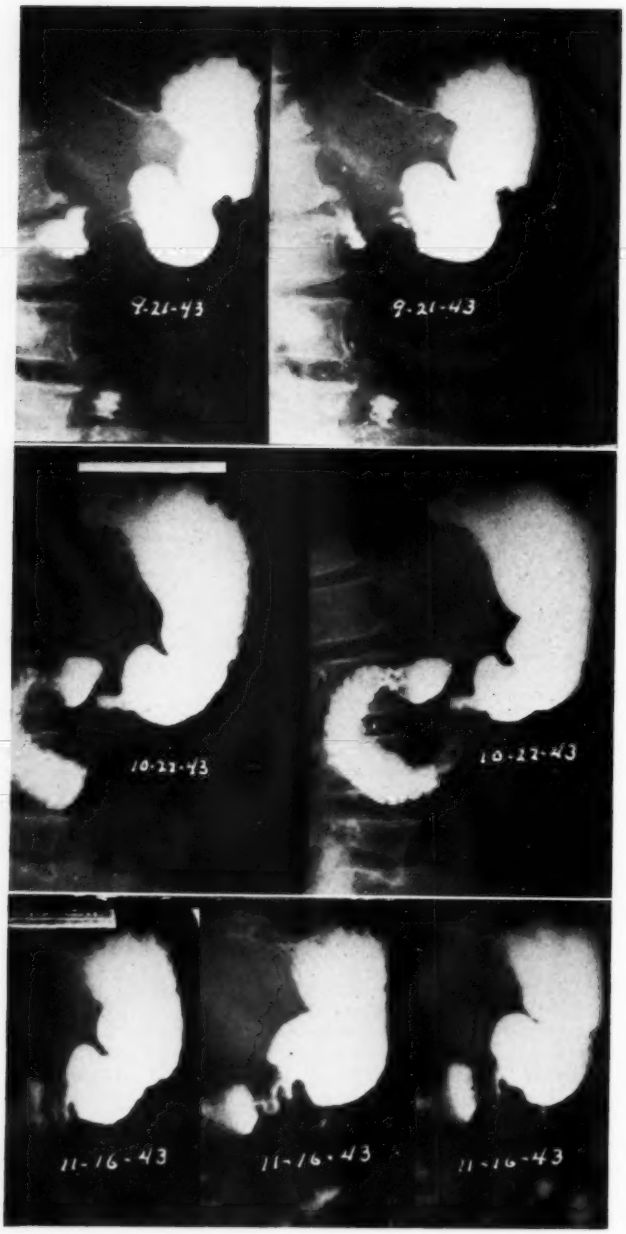
Laboratory Studies: Red blood count 4,350,000; Hgb. 86 per cent; white cell count 10,600. Gastric analysis: amount 110 c.c.; free HCl 55°; total acidity 73°; occult blood positive.

X-Ray Examination: On July 10, 1943, a filling defect was demonstrated in the prepyloric region, with 60 per cent six-hour barium retention. The duodenal cap was not visualized. Impression: prepyloric gastric lesion, possibly carcinoma (Fig. 7). On Oct. 12, 1943, the stomach and duodenum were essentially normal (Fig. 8).

Gastroscopic Findings (July 14, 1943): Marked edema of the antral mucosa with considerable reddening. No evidence of ulceration to suggest a malignant tumor. Impression: antral gastritis with edema (Fig. 2).

Comment: This patient apparently had an acute edematous antral gastritis with almost complete occlusion of the antral lumen. This cleared entirely on a medical ulcer régime. It is impossible to determine whether or not there was an underlying prepyloric benign gastric ulcer.

CASE III: W. M., white male, age 36, admitted Feb. 20, 1944.



Figs. 11, 12, and 13. Case IV. Roentgenograms made on Sept. 21, 1943, show persistent antral spasm and a small ulceration at the junction of the antrum and pars media. On Oct. 22, 1943, there was very little change in the antral lesion. The patient had in the meantime been on a strict ulcer régime. Roentgenograms made Nov. 16, 1943, still show the antral lesion with ulceration. Symptoms were unchanged.

Chief Complaint: Bleeding peptic ulcer for three weeks.

Family History: Non-contributory.

Past History: Irrelevant.

Present Illness: For the past eight or nine years the patient had suffered from gaseous indigestion with considerable bloating and discomfort; for the past seven years he had had epigastric burning, relieved by milk or food. X-ray studies made six years before admission were negative. Twenty-one days ago a sudden profuse hematemesis occurred, followed by another five days later. Multiple transfusions were given.

Physical Examination: The patient was well developed and well nourished, pallid, but in no acute distress. No abdominal masses were palpable. There was some tenderness in the epigastrium.

Laboratory Studies: Red blood cells 3,050,000; Hgb. 60 per cent; white blood cells 8,600. Gastric analysis was not done.

X-Ray Examination: On March 9, 1944, eighteen days after admission, x-ray examination showed a filling defect involving the antrum and considerable irregularity and thickening of the mucosal folds. No definite ulceration was noted. The duodenal cap was deformed but no ulcer crater was seen. Impression: Prepyloric lesion, possibly hypertrophic gastritis (Fig. 9).

On June 2, 1944, there was considerable improvement in the appearance of the gastric mucosa. The persistent pylorospasm noted on the previous examination had in great measure cleared. There was still definite thickening of the mucosa, especially in the antrum (Fig. 10).

Gastroscopic Findings: March 21, 1944, hypertrophic gastritis with ulceration (Fig. 3). June 1, 1944, healing gastritis.

Comment: This patient may be classified as Group 2, with ulceration. It is to be noted that he had rather severe gastric hemorrhage, apparently from the ulcerated hypertrophic gastritis. The second gastroscopic examination showed marked improvement in the general appearance of the mucosa. There was only one small superficial ulceration and there was no evidence of bleeding. The patient is now symptom-free.

Fig. 14. Case IV. Section through benign gastric ulcer. See Fig. 4. ×50.

CASE IV: E. S. C., white male, age 51, admitted Sept. 24, 1943.

Chief Complaints: Indigestion; loss of weight (25 pounds in past six months).

Family History: Irrelevant.

Past History: Irrelevant as given by patient.

Present Illness: The onset dated back about four to five weeks. There was slight intermittent pain in the epigastrium with a constant feeling that some-

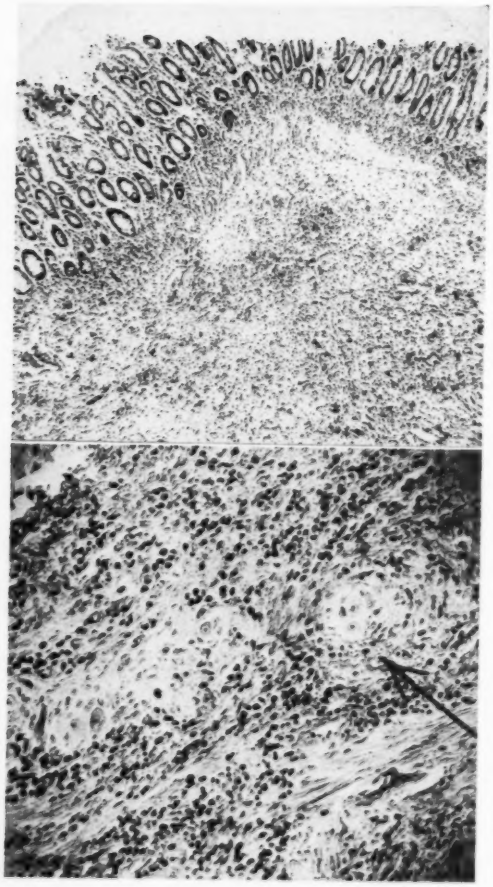


Fig. 15 (above). Case IV. Section through gastric mucosa and muscularis submucosa. Note extensive round-cell infiltration. ×100.

Fig. 16 (below). Case IV. Section through muscularis submucosa. Note extensive inflammatory reaction around ganglia and ganglion cell, indicated by arrow. ×250.

thing was wrong. The discomfort was not altered by food intake or alkalis. Appetite continued fairly good.

Physical Examination: The patient was well developed but somewhat undernourished, not acutely ill. There was slight tenderness in the epigastrium just below the xiphoid process. No masses were present. Heart and lungs were normal.

Laboratory Studies: Red blood cells 4,750,000; Hgb. 94 per cent; white blood cells 6,400. Gastric analysis: amount 150 c.c.; free HCl 9°; total acid 27°; occult blood strongly positive.

X-ray examination showed an ulcerating lesion on the anterior wall of the stomach at the junction of the antrum and media, possibly an early carcinoma (Figs. 11, 12, and 13).

Gastroscopic Findings (Sept. 25, 1943): At the junction of the media and antrum on the anterior wall there was a sharply demarcated, irregular ulcer, measuring approximately 1.4 × 0.4 cm. in diameter. The adjacent mucosa throughout the antrum was nodular, red, and edematous. Impression: A malignant ulcer, such as lymphoma, or hypertrophic gastritis with ulceration (Fig. 4).

Clinical Course: The patient was placed on a strict ulcer régime for a total of eight weeks, including bed rest for the first three weeks. X-ray and gastroscopic examinations were repeated Oct. 22 and Nov. 16, 1943, with no appreciable change. Partial gastrectomy was done Nov. 26, 1944.

Pathologic Diagnosis: Marked hypertrophic gastritis with benign ulcer.

Gross Examination: An irregular sleeve resection of the pylorus was done, the resected portion measuring 12 cm. in width and 15 cm. in circumference. The irregularity consisted of an additional piece of gastric mucosa measuring about 50 mm. in diameter attached to the sleeve along the greater curvature. This appeared to be due to an additional cut through the stomach wall after a partial gastrectomy. The tissue proximal to the pyloric sphincter was edematous and thickened. No rugae were observed in this region. In the central portion of this area, approximately 2.0 cm. proximal to the pylorus, and in the region of the incisura angularis was a superficial erosion measuring 2.0 × 3.0 mm. The mucosa was adherent to the submucosa and in the region of the ulcer presented a rather granular and wart-like appearance. The duodenal portion of the specimen, which averaged about 20 mm. in width, was slightly thickened and more congested than is usually seen.

Microscopic Examination: All sections of the stroma showed a marked increase in lymphoid infiltration, especially near the muscularis mucosa (Fig. 15). Germinal centers were seen in a few of the denser collections of lymphocytes. Sections through the eroded area showed a zone of granulation tissue which was being covered over by epithelium. A small amount of fibropurulent exudate was present on the surface (Fig. 14). The muscularis mucosa was somewhat distorted beneath this area. There was lymphocytic infiltration extending down around the sympathetic ganglia (Fig. 16). Impression: Chronic gastritis: superficial ulceration.

Comment: This patient had all the clinical and roentgen findings of a prepyloric carcinoma. The gastroscopic appearance also was suggestive of a malignant lesion. The impression of the surgeon who did the resection was that it was a malignant infiltration. Histologic studies of the resected specimen showed a chronic hypertrophic gastritis with a benign ulceration.

DISCUSSION AND CONCLUSIONS

Three cases of antral gastritis have been selected for presentation from 576 cases studied gastroscopically. These have been verified by follow-up clinical studies and gastric resection. One additional case that roentgenologically and clinically had the appearance of antral gastritis is also presented. Practically the entire category of symptoms generally associated with gastritis, peptic ulcer, and gastric cancer has been found in these cases. The difficulties of differential diagnosis on the basis of the clinical history, physical examination, x-ray and gastroscopic examinations have been pointed out. Gastroscopy was most helpful in these cases. It should be used more frequently as a supplement to careful x-ray studies, and the results should be correlated with the roentgenologic, clinical, and laboratory findings. If there is any doubt as to whether the lesion is benign or malignant after the findings have been correlated, gastric resection should be done.

Every case of antral gastritis possibly has malignant potentialities. By correlating our roentgenologic and gastroscopic findings with the clinical course, we can more accurately evaluate the prognosis of the disease.

NOTE: I am indebted to my wife, Billie, for the gastroscopic illustrations and to Dr. R. L. Holman, pathologist at Watts Hospital, for the photomicrographs and description of the pathological findings.

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DISCUSSION

Ross Golden, M.D. (New York, N. Y.): Doctor Vaughan has dealt very excellently with the topic, which I think is one of the most intriguing problems we have; which is the diagnosis of antral gastritis and spasm and its differentiation from carcinoma.

In one of the cases shown by Doctor Vaughan, ulcer of the lesser curvature, above the antrum, was present. I have the impression that ulcer of the lesser curvature proximal to the antrum occurs in one-third to one-half the cases with antral spasm and hypertrophy of the pyloric muscle. Some cases have ulceration in the antrum itself, in the narrowed region. Here, the penetrating craters may not be demonstrated by x-ray examination, but are wide open in the specimen after resection. The only apparent explanation for this is that the spasm succeeded in closing off the crater. If there is enough induration about the mouth of the crater, the spasm cannot close it off and it will be visualized. I have ceased to be surprised when the pathologist finds a crater, under these circumstances, which I had not demonstrated in the narrowed antrum.

Doctor Vaughan showed some very interesting cases in which the spasm was nicely relieved by treatment. In many we have seen, the treatment seemed to have no effect on the objective spasm, although the patient's symptoms were improved. I wondered whether the response to treatment has to do with the duration of the disorder. Possibly spasm which persists for a long time becomes associated with organic changes in the antral wall, which prevent relaxation, whereas in more recent cases the spasm can be relieved.

The serious problem is to find out whether cancer is present in the narrowed antrum. One difficulty is that carcinoma may occur in association with the spasm of antral gastritis. In one of our cases cancer developed in the scar of a healed ulcer in a spastic antrum which we had followed over a period of years. Gastroscopy is of high value in antral gastritis with spasm. Doctor Vaughan is to be congratulated upon his initiative in developing himself into a skilled gastroscopist and upon his excellent presentation.

Walter W. Vaughan, M.D. (*closing*): The most significant roentgenological finding in antral gastritis is an abnormality of the antral systole as demonstrated by careful fluoroscopy and serial films. It normally requires twenty-five to thirty seconds for a complete cycle in antral systole.

The technic for gastroscopy with a flexible gastroscope has been outlined in numerous articles and a few textbooks. The most important factor is care-

ful preparation of the patient. We use a moderate amount of sedation, combining morphine and atropine with one of the barbiturates in order to obtain as complete relaxation as possible. The throat and upper portion of the esophagus are anesthetized by surface anesthesia. The examination is done in the fluoroscopic room of the X-ray Department, where the desired degree of darkness may be obtained. A regulation fluoroscopic tilt table is satisfactory. The examination requires from two to five minutes. The majority of patients complain of less discomfort from a gastroscopic examination than from a routine fractional gastric analysis.

The chief contraindications to gastroscopy are: (1) obstruction of the esophagus by intrinsic or extrinsic lesions; (2) subacute perforation of a gastric lesion; (3) coronary disease; (4) psychosis. It is the responsibility of the gastroscopist to see that the necessary studies have been made to exclude these contraindications before attempting an endoscopic study of the stomach.

The addition of gastroscopy to roentgenology in our department for the study of gastric lesions has been found to be of inestimable value in the confirmation of suspected lesions as well as in differential diagnosis.

The Roentgen Appearance of Lobar and Segmental Collapse of the Lung

II. The Normal Chest as It Pertains to Collapse[1]

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A BASIC understanding of both the gross and roentgenologic anatomy of the normal chest is essential to early recognition and accurate evaluation of any disease process within the chest. It is the purpose of this paper, however, merely to emphasize the roentgen appearance of certain structures which are likely to change in shape, size, position, or contour when a lung, or any part of a lung, becomes collapsed.

While some changes are only suggestive of, or consistent with, a decrease in size of a lung or any part thereof, others, when clearly demonstrated, are almost pathognomonic of the presence of collapse.

Our observations are based on a detailed study of approximately 1,200 cases of tumor, bronchiectasis, foreign body, and tuberculosis. The only cases of tuberculosis that are included, however, are those in which a decrease in size of an involved lobe was marked. Postero-anterior and lateral roentgenograms on 160 healthy young adult hospital employees were also examined in an attempt to establish the variations which could be considered normal. In 10 of this group, roentgenograms were taken during both full inspiratory and full expiratory phases of respiration. In approximately 300 of the abnormal group complete bronchographic studies were available; in 3 other persons a complete bronchographic examination during both full inspiration and full expiration was made.

Because of the similarity of the anatomic structures of the two sides of the chest, each roentgenogram offers an immediate and, in the majority of cases, reliable means of discovering unilateral abnormalities. Comparison of an abnormal lung with its normal opposite will often make possible accurate diagnosis of collapse of a lobe or a segment of a lobe.

Heretofore, the variations from normal usually accepted as diagnostic of collapse of the lung were: (1) an abnormal shadow of increased density, (2) elevation of the diaphragm, (3) displacement or shift of the mediastinum, and (4) narrowing of the rib spaces. These variations have been thoroughly studied and presented in the past and require no further discussion at this time. Our study has demonstrated the importance of three additional anatomic factors: (1) the appearance and position of the hilar shadows, (2) the arrangement of the vascular shadows in the peripheral portions of the lung fields, and (3) the demonstration of the actual size of a lobe as determined by the appearance and position of the septa or fissures of the lung.

Anatomically, the hili are approximately at the same level, but roentgenologically the left hilus usually appears to be a few millimeters higher than the right (Fig. 1). This is due, for the most part, to the fact that the left pulmonary artery, which forms the upper margin of the left hilar shadow, is more clearly visualized than the eparterial right main bronchus, which forms the upper margin of the right hilus. The vascular structures as they leave the hilar areas may be distinguished, as a rule, as branches of blood vessels, the distribution of which is more or less uniform. Any marked deviation in the position of the hilus and in the pattern of the adjacent

[1] From the Department of Radiology, Massachusetts General Hospital, Boston, Mass. One of a series of papers accepted for publication in October 1944.

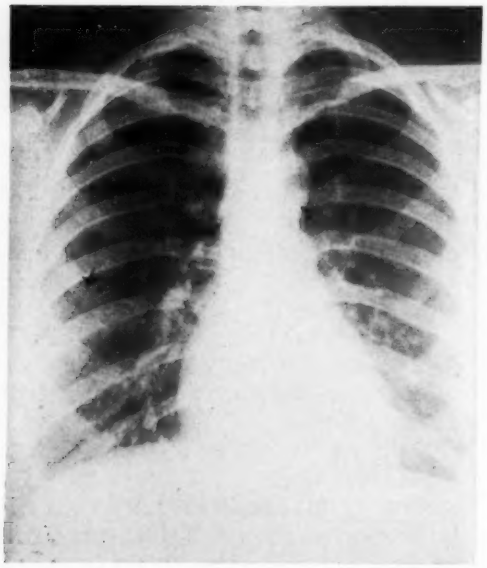

Fig. 1. Chest roentgenogram of a normal, healthy adult. Arrows indicate the superior margin of each hilus and the visible portion of the minor septum.

vascular structures strongly suggests spatial rearrangement within the lung. Such rearrangement frequently results in vertical displacement of the hilar shadow; that is, in collapse of an *upper* lobe the hilus moves upward, and in collapse of a *lower* lobe it moves downward (Fig. 2). When this occurs, one often has the impression that there has been a decrease in the size of the hilus of the involved lung. It is more likely, however, that this apparent decrease is due to the partial obscuring of the lung root by the shadow of increased density and by overlying structures, particularly in those cases in which the hilus is depressed.

The vascular structures in the periphery of the lung fields form a rather fine branching network. On comparison of the two sides of the chest, the pattern in each is seen to be similar in general arrangement and in number of structures visible per comparable area. When spatial rearrangement occurs and one portion of a lung or lobe occupies a much greater area than normally, these vascular structures are separated (Fig. 3). This separation of the normal vascular network serves as a good index of the amount of rearrangement that has occurred. It is the greater amount of air between the vascular structures that accounts for the increased radiability which is usually interpreted as emphysema. Since this increased radiability is not always apparent, however, the spatial rearrangement within the lung is a more definite criterion for determining the presence and degree of emphysema.

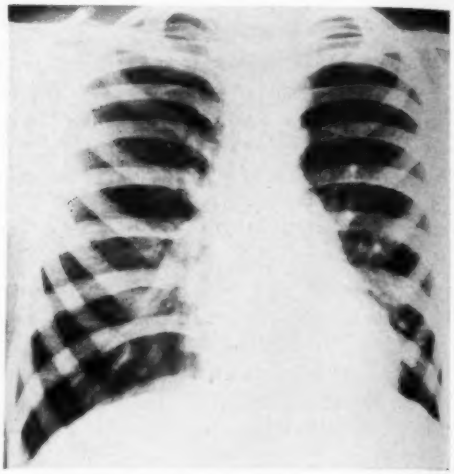

Fig. 2. The left hilus is displaced inferiorly and obscured by the cardiac shadow. There is displacement of the mediastinum to the left, and the left diaphragm is slightly elevated. This appearance was produced by collapse of the left lower lobe due to bronchiectasis, proved by lobectomy.

In the majority of cases, it is possible to demonstrate the actual boundaries of the individual lobes of a lung by means of two roentgenograms. In the postero-anterior projection, determination of the exact lobar distribution of a lesion may not be possible, since obviously in the medial portion of the lung field, at all levels below the fourth thoracic vertebra, more than one lobe is projected on the same plane. Fluoroscopy and the lateral roentgenogram, however, will localize the lesion accurately. The approximating pleural surfaces that define the various fissures are dense enough, when caught on the same plane as the central ray, to be recorded on the roentgenogram, standing out as parti-

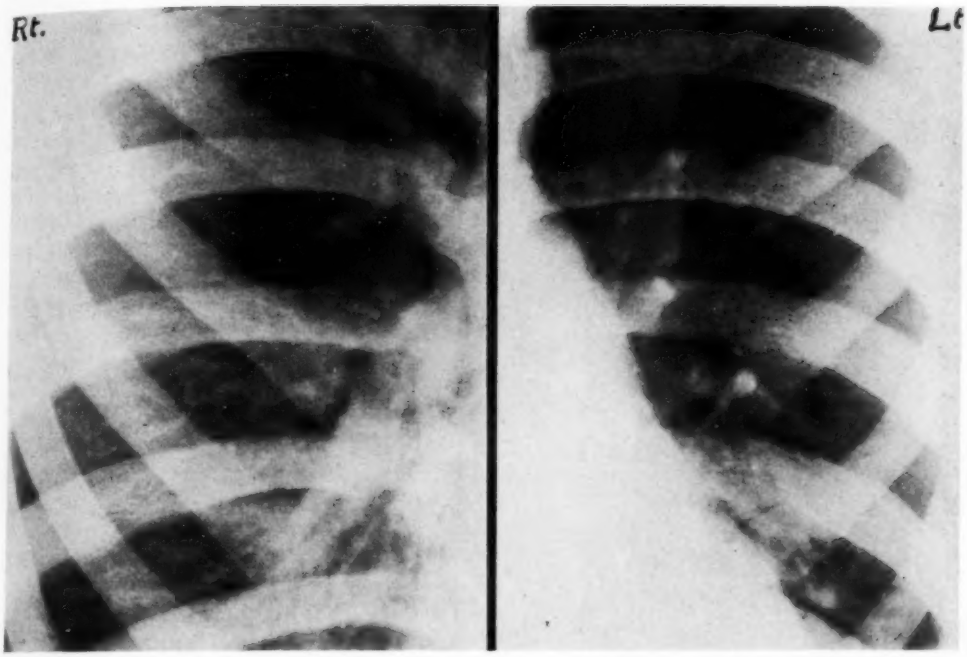

Fig. 3. Enlargement of comparable areas of the lung field of Figure 2. Comparison of the two sides shows fewer vascular shadows per unit area on the left.

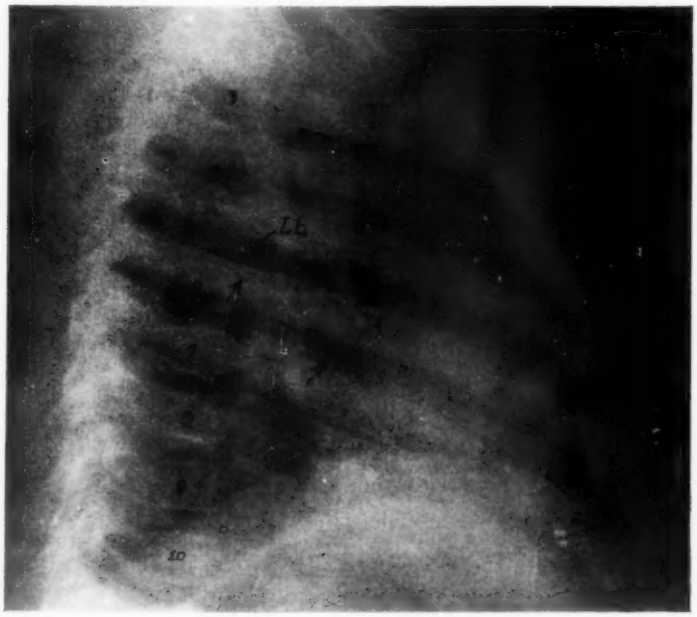

Fig. 4. Arrows indicate the major and minor septa of the right lung and a small portion of the major septum of the left lung.

Fig. 5. The posterior portions of the right major and minor septa are demonstrated.

tions between the lobes. The term septum or septa has, therefore, been considered roentgenologically appropriate and has been used in referring to these fissures. No attempt has been made to discuss anomalous septa.

The major septa divide the lungs on each side of the chest in much the same way, except that on the right side the middle lobe is a separate entity, whereas on the left, the lingula is not separated from the upper lobe and the lingular bronchus arises from the left upper lobe bronchus. In many persons, about one-third of the lower lobes is below the horizontal plane of the dome of the diaphragm and is thus not demonstrable on either single or stereoscopic postero-anterior roentgenograms. The amount of lung obscured by the diaphragm, however, varies with the body build of the individual patient and with the phase of respiration at which the observation is made.

The major septa are demonstrated only on the lateral roentgenogram (Fig. 4). In this projection, they run roughly from the level of the fifth thoracic vertebra (Fig. 5) posteriorly to the most anterior portion of the diaphragm. (In supposedly normal young people, the inferior portion of a major septum meets the diaphragm at a point within 6 cm. of the anterior chest wall, but this observation may not be applicable in the older age group.) Roentgenologically, each major septum appears normally as an almost straight dividing line, with possibly a slight, gentle curve, the convexity being in either direction. On the left side of the chest, the upper lobe lies anterior to and above the greater septum, and the lower lobe below and posterior to it. On the right side, the upper and middle lobes lie anterior to and above the greater septum, while the lower lobe lies below it posteriorly. As a rule, one major septum can be distinguished from the other in the lateral roentgenogram, since on the right side it is met by the minor septum; also, the leaf of the diaphragm which a septum meets can usually be identified. The major septa do not change appreciably in position or contour with various phases of respiration.

Both the postero-anterior and lateral roentgenograms are of value in demonstrating the minor septum. A portion of it, if not the entire septum, can be seen in both these projections in approximately 90 per cent of those examined. This septum appears as a gently curved line and forms the boundary between the upper and middle lobes. It extends from the anterior chest wall, at about the level of the anterior portions of the third to fifth ribs, posteriorly to meet the greater septum in the mid-chest. Although the posterior portion of the septum does not change its position during the phases of respiration, the anterior portion moves upward during in-

spiration in proportion with the change in position of the sternum.

A change in the position or curve of a major septum will become more readily apparent if it is compared in the lateral projection with the septum on the opposite side of the chest. Any marked variation in the position or contour of any septum is strongly suggestive of spatial rearrangement, and should be correlated with the study of the appearance of the peripheral vascular shadows and the position of the hilus on each side of the chest.

CONCLUSIONS

The following changes from normal in anatomic structures are suggested as being of importance as they pertain to collapse of the lung, and particularly to collapse of a lobe or a segment of a lobe:

1. Change in the appearance and position of the hilar shadows.
2. Change in the arrangement of the vascular shadows in the periphery of the lungs.
3. Change in the position and contour of the lobar septa.

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Fibrous Dysplasia of the Skull: A Probable Explanation for Leontiasis Ossea[1]

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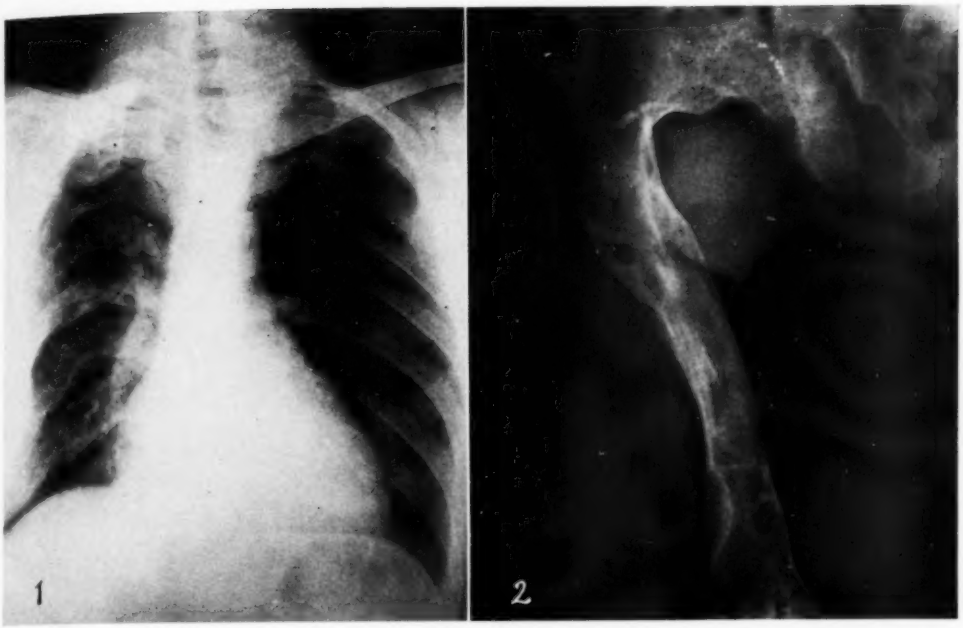
OSTEITIS FIBROSA is a term that has been used for many years to designate any of a heterogeneous group of lesions of bone and is objectionable because it thus lacks any specific connotation. Employment of synonyms, such as von Recklinghausen's disease, fibrocystic disease of the bone, and osteodystrophia fibrosa, has not been helpful, for these designations also have no definite and universally accepted meaning. The first great advance toward clarifying this confusing situation was made when it was recognized that hyperparathyroidism was present in certain cases of so-called osteitis fibrosa. The changes in bone resulting from hyperparathyroidism and those attributable to other types of osteitis fibrosa were found to be dissimilar. It is now possible for roentgenologists to recognize hyperparathyroidism in most cases in which the bones are involved and they do not often confuse changes in bone resulting from that cause with those of other types of osteitis fibrosa.

The next contribution toward a better understanding of osteitis fibrosa was made by Albright and his associates in 1937. They described a syndrome which is characterized by osteitis fibrosa, pigmentation of portions of the skin, and endocrine dysfunction. They recognized that this type of osteitis fibrosa was not due to hyperparathyroidism and, therefore, called these lesions in bone "osteitis fibrosa disseminata" to distinguish them from those caused by hyperparathyroidism, which they called "osteitis fibrosa generalisata." The syndrome described by them has since been known as "Albright's syndrome."

In 1938 Lichtenstein described polyostotic fibrous dysplasia. The changes in the bone were identical with those of osteitis fibrosa disseminata. Lichtenstein and Jaffe, however, found that these lesions often occurred without any manifestation of the non-skeletal components of Albright's syndrome. They observed that often several or many bones were affected but that in some cases only one bone might be involved. Because of this last observation, these lesions are now called "fibrous dysplasia of bone." If more than one bone is involved, the distribution may be indicated by adding the word "polyostotic" to the term "fibrous dysplasia."

Lichtenstein and Jaffe described fibrous dysplasia of bone as a developmental anomaly having its onset in childhood. When more than one bone is involved, there is a tendency for the lesions to be predominantly unilateral, but in many cases there is extensive bilateral involvement. Pain, disability, and deformity are usually present, often due to pathologic fractures. When maturity has been reached, there is either no further progression of the lesions or their progress is very slow. Pathologic fractures may occur at any time, however. The level of the serum phosphorus in cases of this type is normal. The concentration of serum calcium is normal or slightly elevated, and that of serum phosphatase moderately or greatly elevated. The increase in serum phosphatase is in direct proportion to the extent of the skeletal involvement. There is no evidence of hyperparathyroidism. Biopsy reveals that the medullary cavity of the involved bone is filled with gritty, grayish-white fibrous tissue containing newly formed trabeculae of immature bone. The bone is expanded in part or throughout, and the cortex is

[1] Presented at the Joint Meeting of the American Roentgen Ray Society and the Radiological Society of North America, Chicago, Ill., Sept. 24–29, 1944.



Figs. 1 and 2. Polyostotic fibrous dysplasia. The lesions of the bones of the thorax and of the femur are typical of those in the remainder of the skeleton. See also Figures 8 and 9.

thin. A long bone may be abnormally short. The pathologic changes in the bone with, perhaps, pathologic fractures, give a distinctive roentgenographic appearance (Figs. 1, 2, and 3). It must be emphasized that these lesions of the bone are not cysts, although, as a result of their radiolucency, they give that appearance many times.

Lichtenstein and Jaffe stated that the extent of these developmental defects varies greatly. In many cases only the bone-forming mesenchyme shows disturbed development. However, when there is more extensive disturbance, non-skeletal abnormalities also may be present, and such changes as those of Albright's syndrome are manifest.

While there are objections to the term "fibrous dysplasia of bone" and it is not an ideal designation, yet it does serve to emphasize that the lesions constitute a distinct entity and it does replace the abused term "osteitis fibrosa" by one concerning which there is less confusion. It describes fairly adequately the pathologic process and indicates that these lesions are prob-

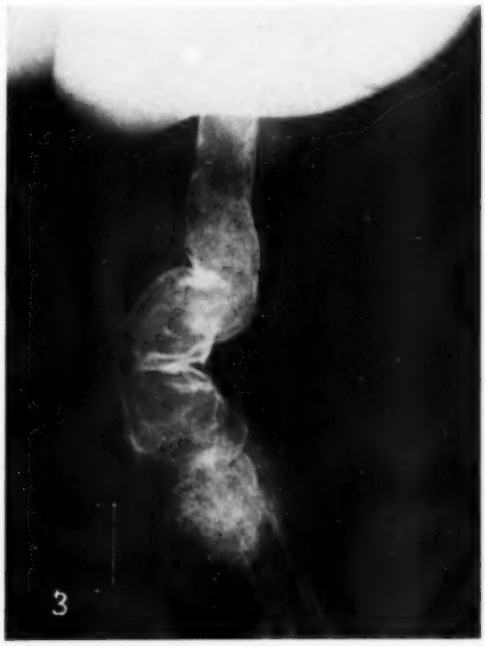
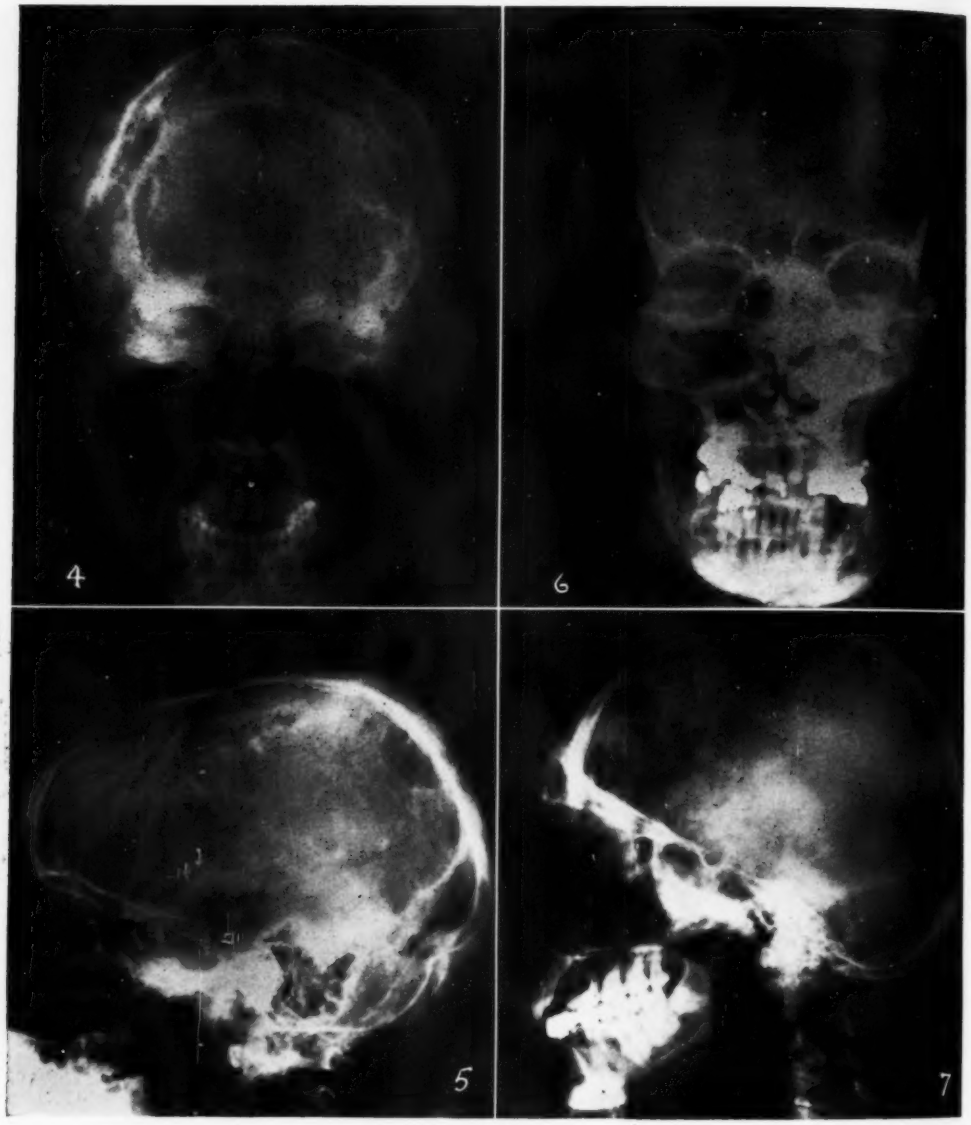


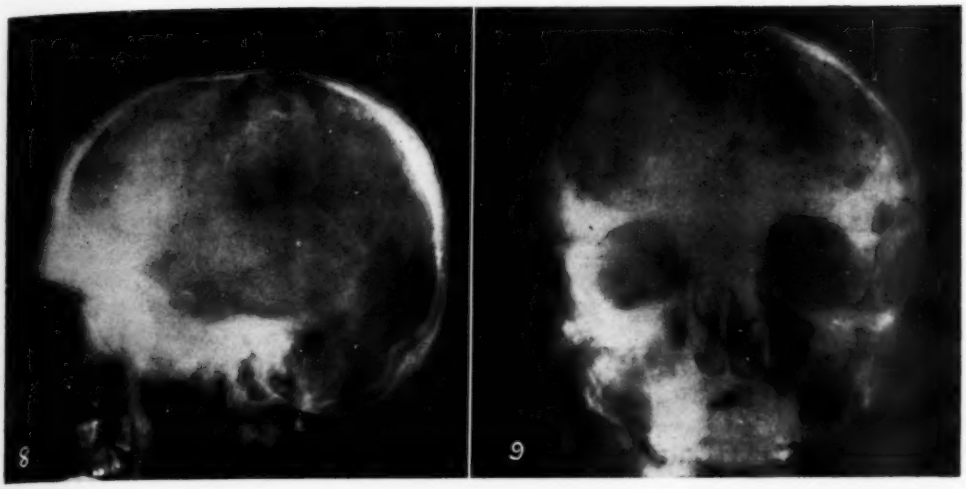
Fig. 3. Polyostotic fibrous dysplasia. Roentgenogram of the femur and tibia showing the extreme change that may be present.



Figs. 4–7. Polyostotic fibrous dysplasia. The patient whose skull is shown in Figure 4 had typical fibrous dysplasia of much of the skeleton. Figure 5 is a roentgenogram of the skull of the patient whose femur and tibia are shown in Figure 3. Figure 6 is the skull of a patient with Albright's syndrome. Note the lesion in the mandible and the obliteration of the right ethmoid and maxillary sinuses. Figure 7 is from a case with lesions of the skeleton similar in character to those shown in the skull.

ably the result of a developmental defect. It does not carry any implication of hyperparathyroidism. The rather general acceptance of the name "fibrous dysplasia of bone" reveals a desire by many to avoid the term "osteitis fibrosa." When there are also non-skeletal manifestations, the term "Albright's syndrome" is satisfactory.

The roentgenologic appearance of long bones which are involved by polyostotic fibrous dysplasia has been described many times. On the other hand, sufficient atten-



Figs. 8 and 9. Skull of patient shown in Figures 1 and 2. The osteomatoid change in the base of the skull should be compared with the fibrous appearing lesions in the vault and occiput. Figure 9 shows especially well the obliteration of the ethmoid sinuses and the left antrum. There is also deformity of the left orbit.

tion has not been paid to the changes in the skull. Etter and Hurst found that next to the femur and humerus the bones of the skull are most frequently involved. The vault of the skull was involved in 73 per cent of the 15 cases of Albright's syndrome recorded by Falconer and his associates, and the face and the base of the skull in 67 per cent.

The roentgenograms in cases of polyostotic fibrous dysplasia, with or without Albright's syndrome, which have been reported in the literature, show changes in the skull that are distinctive and fairly consistent. Furst and Shapiro, Falconer and his associates, and Neller have briefly described the roentgenologic picture.

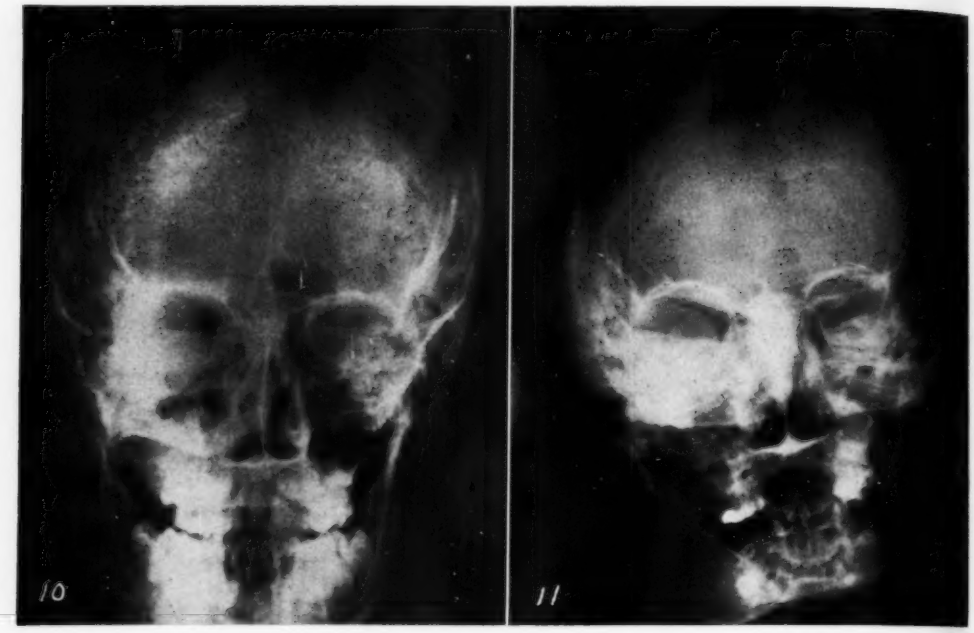
OBSERVATIONS BASED ON STUDY OF CASES

In order further to investigate fibrous dysplasia of the bones of the skull, the roentgenograms and clinical records in 5 cases of polyostotic fibrous dysplasia were first studied. These cases were selected because lesions of the skull were present. In one case, a diagnosis of Albright's syndrome had been made. The skeletal involvement in each instance was extensive and typical of the disease (Figs. 1, 2, and 3).

The changes in the skull observed in the roentgenograms in these 5 patients were identical with those seen in cases reported in the literature. The lesions involving the vault, the occiput, and the mandible resembled closely the type of change which has been observed in the long bones in this disease. The bone had expanded and had the typical appearance that roentgenologists have learned to associate with fibrous dysplasia. Some areas looked sclerotic, but generally the appearance was that once thought to be due to cyst formation but now known to be due to fibrous tissue (Figs. 4 to 7).

The lesions in the frontal, sphenoid, ethmoid, and maxillary bones were different. In these regions the bone appeared to be densely sclerotic. It was abnormally thick, and the paranasal sinuses often were completely or partially obliterated. The density of the bone was often as great as that of an osteoma. For this reason it might be worth while to refer to this as an osteomatoid change caused by fibrous dysplasia of bone (Figs. 8 and 9).

Lesions of the skull in polyostotic fibrous dysplasia may cause asymmetry of the vault or face. The deformity may be predominantly unilateral, but there is almost always some bilateral involvement. De-



Figs. 10 and 11. Fibrous dysplasia of the skull. Figure 10 shows osteomatoid change in the left sphenoidal wings simulating the hyperostosis caused by meningioma. The lesion in the left half of the mandible helps identify this as fibrous dysplasia. Figure 11 shows enlargement of the left mandible, which led to roentgen examination of the skull in this case. The roentgenogram revealed obliteration of the ethmoid sinuses and left antrum and a lesion of the left temporal bone, as shown.

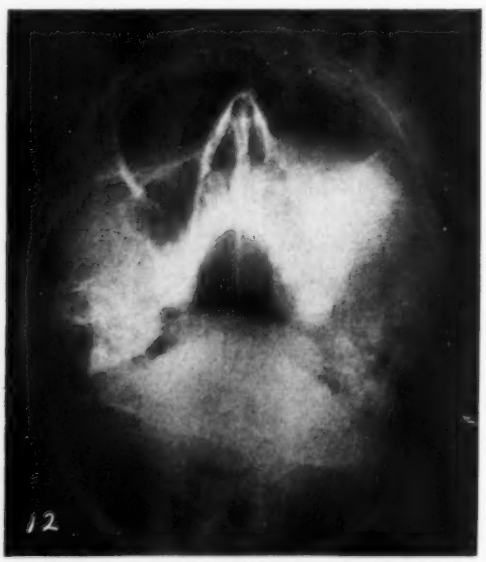
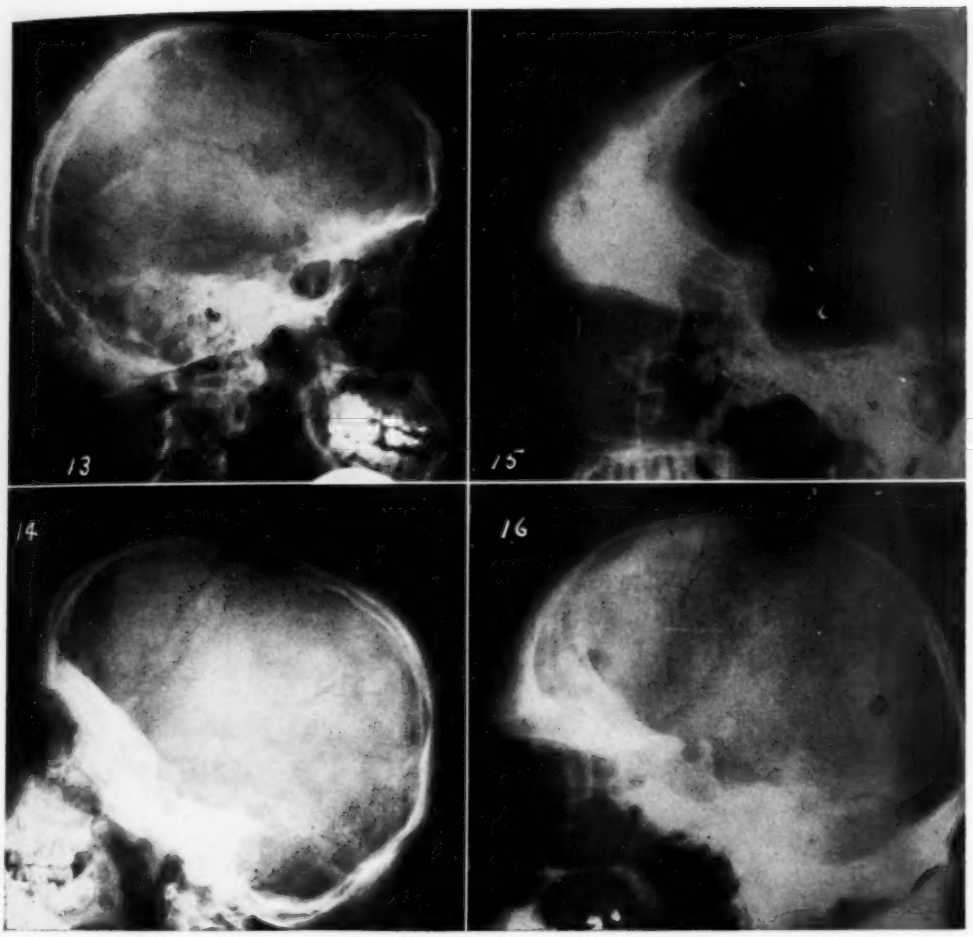


Fig. 12. Fibrous dysplasia of the skull, showing partial obliteration of the right antrum. Lesions of the right frontal bone and the right half of the mandible are also present.

formity of one orbit is not infrequent, and there may be ocular proptosis. Prominence of the frontal bone, maxilla, or mandible is often observed.

Recently Lichtenstein and Jaffe have emphasized that fibrous dysplasia may be limited to a few bones or may even involve only a part of one bone. For this reason it seemed probable that lesions might occur in the skull without involvement of the remainder of the skeleton. A search of the records at the Mayo Clinic revealed that within the last five years 10 cases have been encountered in which the lesions appeared to be limited to the skull. In 7 cases the remainder of the skeleton was not examined roentgenologically. In the other 3 cases roentgenologic examination of the remainder of the skeleton failed to reveal other lesions. In no case were there symptoms referable to any part of the skeleton aside from the skull. Five of these patients were males and 5 were females.



Figs. 13–16. Fibrous dysplasia of the skull. The patient shown in Figure 14 had, also, a lesion of the mandible which does not show in this roentgenogram. Figure 15 is an example of extreme osteomatoid change due to fibrous dysplasia.

In each case the lesions of the skull developed during childhood. There was no evidence of Albright's syndrome. The lesions in this group were similar to those in the cases of polyostotic fibrous dysplasia studied previously. In fact, these also are to be regarded as examples of polyostotic fibrous dysplasia, since in each instance more than one bone of the skull was involved. Roentgenograms from 7 of these cases are reproduced in Figures 10 to 16. It is likely that in some of these 10 cases of fibrous dysplasia lesions of other bones actually were present, also. Certainly this type of lesion in the skull should lead to roentgenologic examination of the entire skeleton.

In many cases, fibrous dysplasia of bone is first detected when a pathologic fracture occurs. Diagnosis of the condition before the occurrence of this complication would be of great benefit to the patient, as proper precautions might prevent such an accident. Recently Helfet has advocated the oral administration of soluble aluminum salts to bring about calcification of these lesions and thereby strengthen the bone. The theory behind this treatment is not accepted by many, but Ghormley and Hinchey, as well as Helfet, have observed

encouraging results with its use. More extensive investigation is warranted.

Among the cases encountered at the clinic, is one which is especially interesting and illustrates well the need for complete roentgenologic examination of the skeleton when lesions of the skull are found. The patient, a boy of twelve, was seen at the clinic in 1927, when a diagnosis of diffuse osteoma of the skull was made. A review of the roentgenograms of the skull showed the lesions to be those of fibrous dysplasia (Fig. 17). This patient had always been large for his age, and enlargement of the head had been noticed since he was five years old. Congenital syphilis had been suspected as the cause of the skull lesions, but its presence was not confirmed. Areas of pigmentation were present in the skin on the back of the neck and over the sacrum. There was bony prominence of the lower part of the sternum, the fifth and seventh ribs on the right, and of a rib on the left. This case is, without much doubt, an example of Albright's syndrome. Undoubtedly there was fibrous dysplasia of some of the long bones of the skeleton.

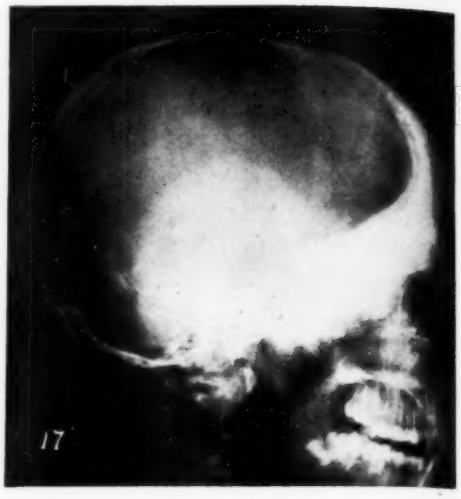


Fig. 17. Fibrous dysplasia of the skull which was probably associated with Albright's syndrome. The original diagnosis, made in 1927, was diffuse osteoma of the skull.

LEONTIASIS OSSEA

The similarity, or rather the identical nature, of the lesions of fibrous dysplasia of the bones of the skull and those lesions which have been called "leontiasis ossea" cannot be discounted. Furst and Shapiro noted this similarity but believed that the two types of lesions could be distinguished. Falconer and his associates also mentioned the similarity and stated that leontiasis ossea is not a specific entity and might be due to polyostotic fibrous dysplasia in some instances. In cases of leontiasis ossea which have been reported in the literature, the roentgenograms of the skull reproduced invariably show changes identical with those of fibrous dysplasia.

Since leontiasis ossea is not a specific disease but merely describes a type of deformity, one cannot say that there is but one method of pathogenesis. In most cases, however, it seems to be due to fibrous dysplasia of the bones of the skull.

CONCLUSIONS

From this study the following conclusions are drawn:

1. Lesions of the skull associated with polyostotic fibrous dysplasia have a characteristic roentgenologic appearance.
2. Fibrous dysplasia of the bones of the skull occurs at times without obvious involvement of the remainder of the skeleton.
3. If fibrous dysplasia of the bones of the skull is found, roentgenologic examination of the entire skeleton should be carried out.
4. In most cases it seems probable that leontiasis ossea is a manifestation of fibrous dysplasia of the bones of the skull.

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DISCUSSION

Lieut. Comdr. John D. Camp, (MC) U.S.N.R.: Dr. Pugh's paper illustrates, I think, the need for the continued interest of the roentgenologist in these bizarre bone lesions. We were able to segregate the condition of hyperparathyroidism from this group. Dr. Albright carried the matter further, with the recognition of the syndrome which now bears his name.

I was interested in a short editorial comment in last week's issue of the *Journal of the American Medical Association* [Sept. 16, 1944] in which it was suggested that Albright's syndrome, as represented by these cases of fibrous dysplasia that Dr. Pugh has shown, are all due to neurofibromatosis or von Recklinghausen's disease. I think a more convincing argument will have to be put forth before most of us can accept that theory.

Another important point concerning the group that Dr. Pugh discussed is the fact that these lesions occur in the young and that most of them show a tendency to regress in their rate of growth after puberty. This is especially significant in those lesions which we used to call fibrous osteoma of the nose and nasal sinuses. This is frequently a very deforming lesion and is important to the radiologist because, by giving adequate radiation therapy, he may be able to control its rate of growth. Thus, many of the disfiguring deformities of the face are minimized, since, as just pointed out, the lesion has a tendency to slow up greatly after puberty.

Merrill C. Sosman, M.D. (Boston, Mass.): I would agree entirely with Dr. Camp in his discussion of Dr. Pugh's paper on the importance to roentgenologists of the recognition of this peculiar dysplasia of bone. When Dr. Fuller Albright reported his series of cases from Boston several years ago, we had already collected 9 cases of that same disease in patients who had been sent to Dr. Cushing for his determination as to whether or not they harbored a meningioma. That is the one condition that is most apt to be mimicked or even so diagnosed when fibrous dysplasia involves the cranial bones. We were working on those patients, getting biopsies and doing chemical studies, tending toward a paper on the subject, when Dr. Fuller Albright published his group, and we dropped the matter. Since then, however, we have seen six more cases. So there are fifteen in our little hospital in Boston.

Many names have been given to this condition. Fuller Albright called it "osteitis fibrosa disseminata." We called it "osteitis fibrosa localisata" because most of our cases were limited to the skull and even, like some of those of Dr. Pugh, to one side of the skull, particularly the perpendicular plate and the horizontal plate of the frontal bone, and occasionally the maxilla or mandible on the same side. Many of them had a definite depression of the eyeball. The orbit was partly overgrown by abnormal bone so that the patient presented exophthalmos as a symptom of the deformity and sometimes definite failure of vision due to the dislocation of the eyeball.

I can add one thing to Dr. Pugh's observations and Dr. Camp's discussion, and that is that the growth of this abnormal bone can apparently be stopped and it can be turned into more adult bone by x-ray treatment, and this does not require a very large dose, 750 to 800 r. (I hope you will avoid the excessive doses which we discussed in the therapeutic section yesterday, which may produce brain damage.) Three of our group of patients had definite cysts. They were not neoplastic areas in the bone but a cystic degeneration. In two of them we did biopsies. The erroneous histological diagnosis in one was giant-cell tumor and the other was called a myeloma. Both healed promptly with x-ray therapy. That is one indication of some possible benefit.

Radiation Therapy of Carcinoma of the Thyroid[1]

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MOST PAPERS on carcinoma of the thyroid are from centers where great numbers of patients with thyroid disease are treated. The volume of patients seen and operated upon permits the observation and treatment of a large number of early malignant neoplasms. The experience with thyroid carcinoma in a general hospital is quite different. At Bellevue Hospital only 64 cases of thyroid carcinoma have been seen since 1924 in the Radiation Therapy Department. These cases, unlike those seen at centers of thyroid treatment, are for the most part far advanced. Many of the patients were referred from other institutions where surgery had been done but no radiation had been given until recurrence or metastasis occurred.

There are many interesting and informative papers on carcinoma of the thyroid. Lahey, Hare, and Warren (8, 15, 16, 27) have written a series of reports on the findings at the Lahey Clinic. In the most recent paper a series of 231 cases is summarized. Another series, that of the Cleveland Clinic, was recently reviewed by Portmann (23, 24), who reported 220 cases seen since 1922. A third extensive series reported by Pemberton and his associates (1, 18, 19, 20, 21, 22) consists of 774 cases seen at the Mayo Clinic between 1907 and 1937. Welti and Huguenin (29) reported 88 cases, and Watson and Pool (28) 167. Many other excellent papers describe the unusual features of from one to hundreds of cases.

INCIDENCE

From a review of statistics, it might appear that the number of cases of malignant neoplasm of the thyroid is increasing. Authorities are of the opinion, however, that this increase is more apparent than real and that advances in clinical and pathological diagnosis are largely responsible. The proportion of malignant lesions among thyroid tumors has been variously estimated at from 1 to 5 per cent. Lahey, Hare, and Warren found that their 231 cases represented 1.2 per cent of 18,600 thyroids operated upon. Crile and Crile (2, 3) reported 289 carcinomas among 17,021 thyroid patients, or 1.69 per cent. These 289 cases constituted 3 per cent of nodular goiters. Pemberton found the incidence varying from 2 per cent in 1919 to 4.9 per cent in 1937. Welti and Huguenin's estimate is 1.3 per cent. According to Hare, deaths from thyroid cancer represent 0.66 per cent of all carcinoma deaths in the United States.

The age incidence varies widely, cases having been reported from early childhood to the nineties. Moreover, it is becoming increasingly recognized that carcinoma has a predilection for the thyroid in childhood. Because of this, it is no longer customary to defer operation in children with thyroid nodules. The incidence is greatest between the ages of forty and seventy, slightly less from thirty to forty and seventy to eighty. The occurrence of thyroid carcinoma in the various decades among our 64 cases is presented graphically in Figure 1. The average age is about fifty years and is slightly lower in females than in males. There are far more cases among females, the ratio being approximately 2:1 in large series. Of our 64 cases, however, 32 were in males and 32 in females. Our youngest patient was born

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[1] From the Radiation Therapy Department, Bellevue Hospital, Dr. Ira I. Kaplan, Director. Read by title at the Twenty-ninth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Dec. 1-2, 1943.

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with a carcinoma of the thyroid (Case 1) and the oldest was eighty-three.

PATHOLOGY

One finds almost as many systems of classification of thyroid neoplasms as there are writers on the subject. Close analysis, however, shows the difference to be mainly one of terminology, for there is general agreement as to the types of neoplasm. The simplest classification is that of Pemberton. His classification, which is that of the Mayo Clinic, is as follows:

1. Papillary adenocarcinoma
2. Adenocarcinoma in adenoma (malignant adenoma)
3. Diffuse adenocarcinoma
4. Epithelioma
5. Sarcoma

Criteria of Malignancy: There is still some confusion as to the differentiation between benign and malignant thyroid tumors. The subject has been clarified, however, by Graham (6), who set the following standards which may be used as criteria of malignancy: (1) local invasion of capsule or surrounding structures; (2) recurrence of original tumor after surgery; (3) metastasis to lymph nodes or distant structures; (4) death due to the size of the tumor; (5) invasion of blood vessels. This last was Graham's outstanding contribution to the subject, for it may be easily recognized. He described the following stages of blood vessel invasion: (*a*) gross thrombus; (*b*) gross erosion; (*c*) microscopic presence of cells or tissue in blood vessels; (*d*) microscopic evidence of invasion of blood vessels other than capillaries or sinuses.

Papillary Adenocarcinoma: Papillary adenocarcinomas comprise approximately 30 per cent of malignant thyroid neoplasms. The lesion is of low-grade to moderate malignancy. There is, however, a tendency to early metastasis to the regional lymph nodes, and such metastases may be the presenting feature while there is still no palpable tumor in the thyroid. This has led some to entertain the concept of lateral aberrant thyroids. Pemberton, however, considers such deposits almost always metastatic from a primary thyroid lesion. Though they metastasize early to the lymph nodes, papillary adenocarcinomas are slow to spread to the lungs and mediastinum and rarely involve other organs. Histologically they are characterized by their papillary structure. Even when the tumors are not completely resectable, the prognosis is good, for they are radiosensitive.

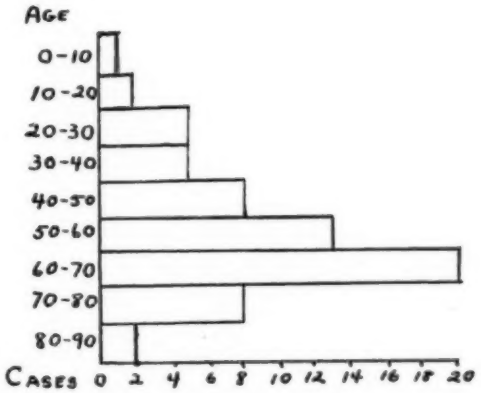

Fig. 1. Age incidence of 64 cases of carcinoma of the thyroid.

Adenocarcinoma in Adenoma (Malignant Adenoma): Approximately 50 per cent of malignant thyroid tumors are the so-called malignant adenomas. They are of moderate malignancy, chiefly of grades 1 and 2, though grades 3 and 4 are sometimes seen. The tumors vary in structure and are classed as fetal and alveolar or colloid. The majority are of the fetal type and are characterized by a variety of structures ranging from undifferentiated cords of cells to distinct follicles. Unlike the papillary adenocarcinomas, they are relatively late in reaching the lymphatics. It is not until the capsule has been broken that the tumor spreads by this route to involve the lymphatics and regional nodes. However, because of the tendency to invade the venous channels, these lesions spread more rapidly by the blood stream and give a much larger percentage of distant metas-

tases. To this group may be assigned the cases which were formerly considered as "benign metastasizing goiters." When complete excision is possible, prognosis is good. Even those lesions which cannot be completely removed offer a fair prognosis because of their radiosensitivity.

Diffuse Adenocarcinoma: In the larger series, diffuse adenocarcinomas comprise approximately 20 per cent of thyroid carcinomas. It is this group which has been described under various headings, including sarcoma. There is a wide variety of cellular structure, from adult alveolar arrangement to undifferentiated, highly anaplastic invasive lesions resembling sarcoma. Diffuse adenocarcinoma is a more malignant type of lesion than those described previously. Metastasis occurs by way of both the lymphatics and the blood stream. Because of their tendency to extend into the surrounding tissues, these tumors are more frequently recognized clinically than the other types of thyroid cancer. They include the infrequent Hürthle-cell carcinomas.

Squamous Epithelioma: Squamous epithelioma is most often the result of spread from neighboring structures. Through metaplasia, however, it may occur primarily in the thyroid, constituting perhaps 1 per cent of all carcinomas of the thyroid gland. The prognosis is very poor, for complete excision is difficult and the lesion is resistant to radiation.

Sarcoma is extremely rare and accounts for less than 1 per cent of cases. It is unusual for a patient with a thyroid sarcoma to survive as long as a year.

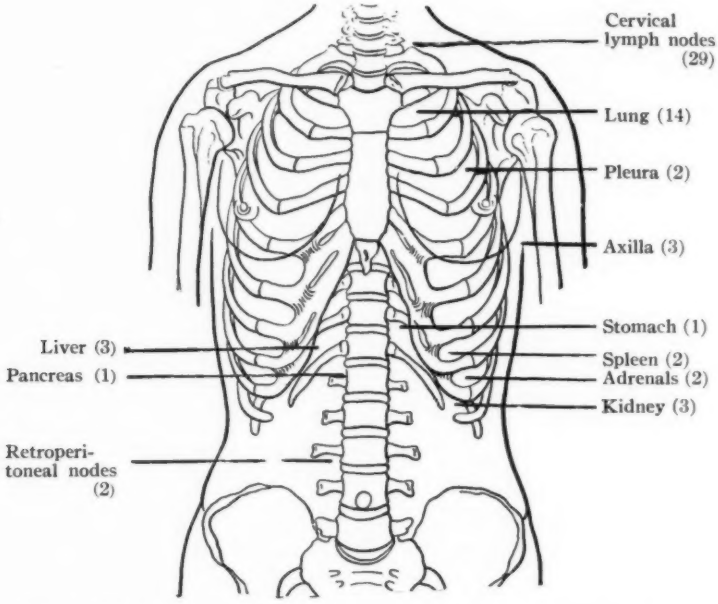

Fig. 2. Metastases in 64 patients with thyroid carcinoma. See also Fig. 3.

METASTASES

Metastasis has been reported from the thyroid to most of the structures of the body. Spread occurs by direct extension, the lymphatics, the blood stream, or any combination of these. The organs affected are, in the order of frequency: the regional lymph nodes, mediastinum, lungs, bones, liver, kidney, pleura, and brain. Metastases have also been described in the pancreas, breast, spleen, and even the retina and palate. In one of our cases (Case II)

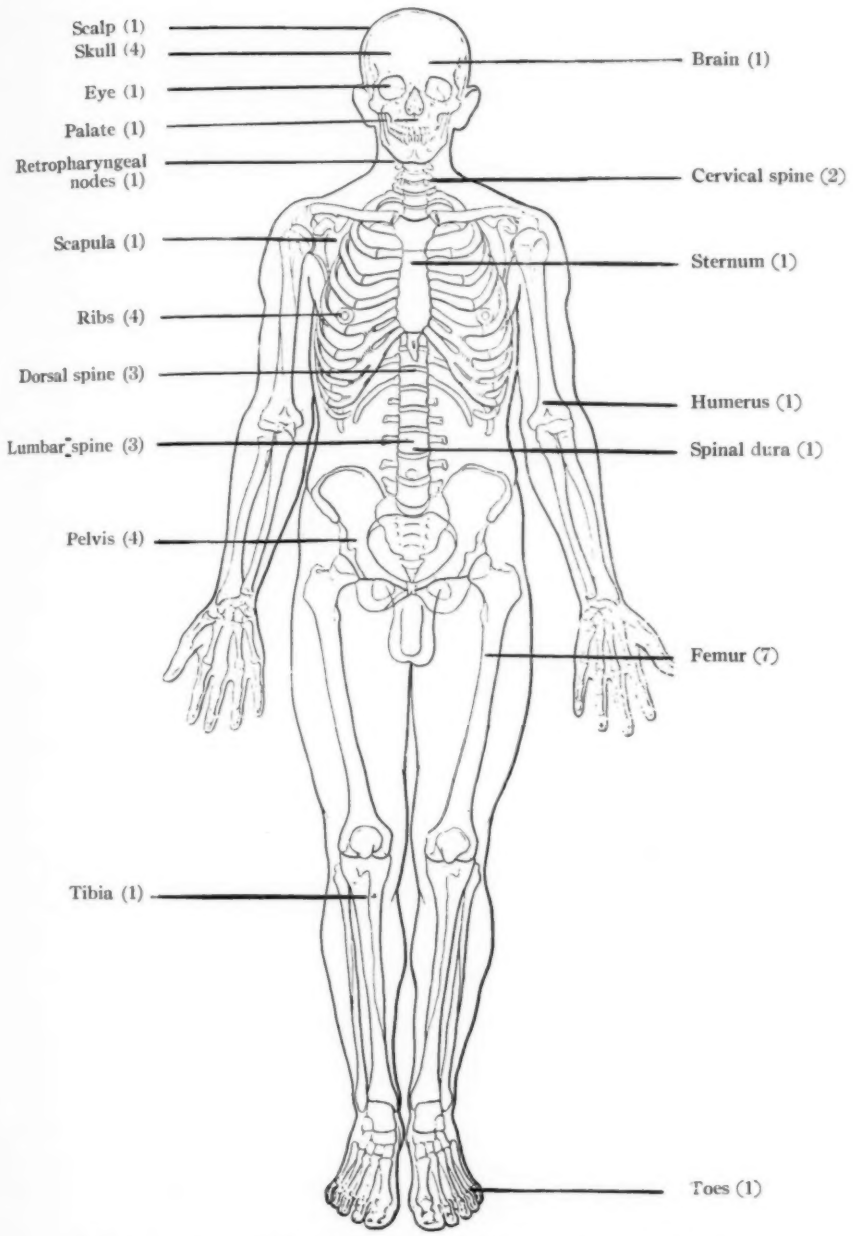

Fig. 3. Metastases in 64 patients with thyroid carcinoma. See also Fig. 2.

bone metastases appeared sixteen years after operation. Of our 64 patients, 15 showed no evidence of metastasis, 22 had metastases in a single organ, 15 in two organs, 7 in three organs, and 1 each in five, six, seven, and eight different organs. (We consider the skeletal system as a single organ.) Figures 2 and 3 show the distribution and incidence of metastases in our series.

CLINICAL PICTURE

In a large percentage of thyroid carcinomas, the diagnosis is made only at operation or even at subsequent pathologic examination. There is an inverse relationship between the stage of the disease and its clinical recognition. As clinicians are becoming more aware of the entity, however, a greater percentage of early cases are being recognized preoperatively. There are certain diagnostic criteria which are pathognomonic, and others which are highly suggestive.

(1) *Recent enlargement* of a pre-existing thyroid adenoma should always arouse suspicion of malignant change. The appearance of a growing mass in a previously normal thyroid should be regarded with suspicion. It will be found that in the average case there is a history of stationary adenoma for years, with enlargement beginning only in recent months.

(2) *Pressure symptoms* such as dyspnea and dysphagia are frequent complaints. Crile and Crile state that 82 per cent of their patients had pressure symptoms. These are often quite out of proportion to the size of the tumor.

(3) *Hoarseness*, resulting from involvement of the recurrent laryngeal nerve, is an important symptom. Benign thyroid tumors almost never cause paralysis of the vocal cords, whereas 15 to 20 per cent of patients with carcinoma of the thyroid manifest this phenomenon. According to Crile and Crile, abductor paralysis of one or both vocal cords in a patient with goiter who has not been operated upon is strong presumptive evidence of a malignant neoplasm.

(4) *Firm consistency* of the tumor is suggestive of malignancy. Some adenomas are firm, but they rarely have the stony hardness of adenomas which have undergone malignant change. This is particularly significant if it represents a change in consistency.

(5) *Change in outline* of the tumor is also important evidence. Invasion into and through the capsule may result in a firm nodular projection.

(6) *Loss of mobility* of a previously movable tumor may also follow invasion of the surrounding tissue, with fixation to underlying structures.

Despite these diagnostic criteria, carcinoma of the thyroid is still diagnosed preoperatively in less than 50 per cent of cases.

DIFFERENTIAL DIAGNOSIS

The chief conditions from which malignant lesions of the thyroid are to be distinguished are benign adenoma with hemorrhage and thyroiditis of the Riedel struma type. In the former the enlargement will be more rapid than in malignant growth. In thyroiditis there are several points of differentiation. Though the gland may be stony hard, it does not lose its normal contour. Secondly, the condition is usually diffuse, involving both lobes and the isthmus, which is unusual for cancer. Thirdly, regional lymph node involvement is rare in thyroiditis.

Portmann has suggested a classification into stages which depend on the amount of involvement. He divides the cases into four groups. *Group 1* includes those cases in which a preoperative diagnosis of carcinoma was not possible and in which the diagnosis was made only on histologic examination. *Group 2* includes cases without the usual clinical evidence of carcinoma, in which the diagnosis is suspected because of recent enlargement or because of the patient's age. In *Group 3* there is clinical evidence of malignant growth extending beyond the capsule of the tumor but no distant metastases can be detected. *Group 4* is composed of those cases which have the qualities of Group 3 as well as clinical or roentgen evidence of distant metastases.

TABLE I: CLASSIFICATION OF 64 THYROID CARCINOMAS

Group I.....	3 cases
Group II.....	5 cases
Group III.....	5 cases
Group IV.....	51 cases

In Table I we have listed the distribution of our cases according to groups. It will be seen that the majority are in Group 4; very few are in Groups 1 and 2.

RELATION TO HYPERTHYROIDISM

The presence or absence of hyperthyroidism is not of value in differentiating malignant thyroid lesions from those which are benign. Crile and Crile feel that in the presence of hyperthyroidism a diagnosis of malignant growth should be made with hesitancy. Pemberton, however, found evidence of hyperthyroidism with an elevated basal metabolic rate in 33.5 per cent of his patients. Davis (4) reported hyperthyroidism in 28 per cent of 50 cases. Others have confirmed this impression. Of our 64 patients, 25 per cent had an elevation of the basal metabolism rate varying from +15 to +100, as well as other evidences of hyperthyroidism.

TREATMENT

The ideal treatment is early and complete excision with subsequent irradiation. Some cases which are inoperable may be rendered operable by irradiation. Recurrent nodules should be excised and the tumor-bearing area irradiated.

In *radiation therapy*, the aim is to give a cancerocidal dose to the tumor-bearing area and its lymphatic drainage. To do this in thyroid patients, we routinely treat both sides of the neck and the anterior and posterior mediastinum. Distant metastases are treated symptomatically.

For the average case, the factors are: 200 kv., 20 ma., 50 cm., 0.5 mm. Cu and 1.0 mm. Al or Thoraeus filter, with a portal of the size best suited to the patient. On each side of the neck we treat from the clavicle to the mandible. Over the anterior and posterior mediastinum we use 10 × 15-cm. portals in the average case. We give either 200 r to each of two portals or 300 r to one portal daily. All cases are treated to skin tolerance. After six to eight weeks, if the skin is in satisfactory condition, the treatment may be repeated.

When there is residual tumor following the second course of x-ray therapy, we prefer to change the quality of the radiation by using pure gamma rays in the form of the 5-gram radium pack or a collar containing radium tubes. Subsequent therapy is given as indicated.

The complications which arise are treated symptomatically. Epidermitis occurs toward the end of treatment. Thorough lubrication of the skin with a bland ointment is prescribed and this lessens the severity of the reaction. When the skin breaks down, aquaphor ointment is applied. For severe pain, nupercain ointment is prescribed. For sore throat and laryngeal and tracheal irritation, gargles, bland foods, and nuperal lozenges are used. Should edema of the larynx occur, with obstructive symptoms, intubation should be tried and, if this is unsuccessful, tracheotomy should be performed.

REPORT OF SELECTED CASES

CASE I: C. C., a nine-month-old white female, was first seen in our clinic on Dec. 20, 1940, with the following history. At birth, on March 12, 1940, a mass was observed in the anterior portion of the neck. X-ray treatments of undetermined quantity and quality were given in the hospital and the child was discharged two weeks after birth with no reduction in the size of the mass. At the age of six weeks she was readmitted because of continued enlargement of the mass in the neck, which was beginning to cause dyspnea and stridor when the child became excited or cried. Physical examination at that time showed three masses, firm and clearly defined, 3 to 5 cm. in diameter, one on each side in the anterior triangle and one in the mid-line of the neck. Though these were not fixed to the skin, there was fixation to the underlying structures. There were engorgement of the veins of the neck, respiratory stridor, and difficulty in swallowing.

On April 20, 1940, operation was undertaken, and the masses in the neck were found to have the appearance of thyroid tissue. They were surrounded by a dense capsule and were firmly fixed to the underlying tissues in the peritracheal area. A subtotal resection of the masses was performed.

The excised masses were somewhat nodular in appearance, firm on palpation, with a capsule over two-thirds of their surface. On section, they showed a meaty, lobulated surface from which no colloid could be expressed on pressure. Microscopic examination showed a diffuse picture of large cuboidal cells with an acidophil cytoplasm and small nuclei. These formed compact, small, and fairly uniform alveoli. In some sections there was a more marked variation in the size and shape of the alveoli than in others. Only a scant fibrotic stroma was present. The basement membrane appeared intact. *Diagnosis:* Adenocarcinoma of the thyroid of the Hürthle-cell type.

TABLE II: X-RAY TREATMENT OF CASE I

(200 kv., 0.5 mm. Cu + 1.0 mm. Al filtration, 0.9 h.v.l., 20 ma., 50 cm. T.S.D.)

Field Treated	Field Size	Dose per Exposure (in air)	Total Air Dose	Interval	Dates
		First Course			
Left neck	5 cm. circle	200 r	1,600 r	Daily	12/20/40 to 1/13/41
		Second Course			
Right neck	6 cm. circle	200 r	1,400 r	1 area daily	2/11/41 to 3/11/41
Left neck	6 cm. circle	200 r	800 r	1 area daily	2/11/41 to 3/11/41
Post. mediastinum	8 × 10 cm.	200 r	1,000 r	1 area daily	2/11/41 to 3/11/41
Ant. mediastinum	8 × 10 cm.	200 r	1,000 r	1 area daily	2/11/41 to 3/11/41

The postoperative course was good, and the patient was discharged on June 19, 1940. There was still pressure on the vital structures, however, as evidenced by stridor when the child cried and difficulty in swallowing. For a short time after discharge the masses in the neck appeared to remain stationary. They then increased in size and caused further symptoms. The patient was admitted to Bellevue Hospital and was seen by us on Dec. 20, 1940.

On the right, in the anterior triangle of the neck, there was a firm mass measuring 4 × 3 × 3 cm. Below this were several nodes, 0.5 to 1.0 cm. in diameter, which were freely movable. On the left was a mass 3 × 2 × 2 cm. Several nodes, about 0.5 cm. in diameter, were palpable in each axilla and inguinal area. The veins of the neck were engorged and breathing was stertorous. X-ray examination showed a large soft-tissue mass on the right side of the neck, displacing the trachea to the left and compressing it. There was widening of the superior mediastinum. No evidence was obtained of metastases in the lungs or skeletal system.

X-ray therapy was instituted on Dec. 20. A 5-cm. area, including the node on the left side of the neck, was treated, as shown in Table II. During therapy and subsequently there was little or no evidence of regression of the tumor. On Feb. 11, 1941, therapy was begun to an area 6 cm. in diameter in the right neck and areas 8 × 10 cm. in the anterior and posterior mediastinum, as shown in Table II. There was roentgen evidence of decrease in the size of the superior mediastinal mass, but little change occurred in the size of the cervical masses. Dyspnea, stridor, and dysphagia increased. On March 31, 1941, it became necessary to do a tracheotomy. Bronchopneumonia developed and the child died on April 4, at the age of one year and three weeks.

CASE II: B. B., a 48-year-old white Rumanian Jewish male, was first seen in our service on Dec. 16, 1941, complaining of severe back pain which had been intermittent for a year. In 1923 he had a hemithyroidectomy in another city, for hyperthyroidism. His basal metabolic rate at that time was +45. The pathological report was adenocarcinoma in adenoma. The patient was then well until November 1939, when he again suffered from back pain, followed by the appearance of a mass over the dorsolumbar area. There were pain and weakness of the legs and other evidence of tumor at the level of D12-L1. Laminectomy was done, and some tissue was removed for examination. The report was carcinoma metastatic from the thyroid to the spinal dura. Some relief of symptoms ensued, but backache persisted intermittently until the present admission following a day of severe pain. The patient complained, also, of nervousness, irritability, tremors, and palpitation.

Physical examination showed the following positive findings: *Head:* fine fibrillary twitching of tongue. *Neck:* transverse scar with no evidence of thyroid enlargement or masses. *Chest:* cardiac enlargement; regular sinus rhythm. *Back:* 25-cm. scar over dorsolumbar spine, tender to pressure. *Extremities:* fibrillary tremor of hands.

The blood findings were not significant. The basal metabolism rate on Dec. 12, 1941, was +45, on Jan. 8, 1942, +38.

Chest roentgenograms showed circular areas of increased density at both lung bases, suggesting metastatic deposits. There was a destructive process of the second left rib, with extension to the pleura. D-11, D-12, and L-1 showed evidence of laminectomy. In the skull a circular osteolytic area was demonstrable, and the right femur showed a similar area of involvement. Radiation therapy was given as outlined in Table III.

Some temporary improvement was observed during and after treatment, which was completed between Dec. 16, 1941, and Jan. 2, 1942. On Feb. 3, however, the patient was readmitted with exacerbation of pain and hyperthyroidism. Therapy was repeated as shown in Table III, second course. Some improvement followed, but the patient remained in the hospital until April 20, 1942, when he was transferred to another institution for custodial care. On Jan. 27, 1944, he was still alive. He complained of some pain in the right leg. He had been given radioactive iodine. The hyperthyroid symptoms were lessened and the basal metabolism was +6.

CASE III: N. S., a 25-year-old white Italian female, was first seen in our clinic on March 10, 1938. In 1937 a swelling had appeared in her neck, which gradually increased in size. During the year of its development she became nervous and irritable and experienced a choking sensation when she wore a collar, these symptoms being aggravated during the

TABLE III: X-RAY TREATMENT OF CASE II

(200 kv., 0.5 mm. Cu + 1.0 mm. Al filtration, 0.9 h.v.l., 20 ma., 50 cm. T.S.D.)

Field Treated	Field Size	Dose per Exposure (in air)	Total Air Dose	Interval	Dates
		First Course			
Dorsolumbar spine	10 × 20 cm.	200 r	2,000 r	Daily	12/16 to 12/31/41
Ant. rt. upper femur	Open cone	150 r	600 r	Every 2d day	12/22 to 1/2/42
Post. rt. upper femur	Open cone	150 r	600 r	Every 2d day	12/22 to 1/2/42
		Second Course			
Dorsolumbar spine	8 × 20 cm.	200 r	1,200 r	2 areas daily	2/3 to 2/20/42
Ant. rt. upper femur	Open cone	150 r	1,200 r	2 areas daily	2/3 to 2/20/42
Post. rt. upper femur	Open cone	150 r	1,050 r	2 areas daily	2/3 to 2/20/42

menstrual periods. She was also hoarse, particularly in the morning.

The patient was admitted to the hospital on Aug. 16, 1937. Physical examination revealed a fullness over the thyroid cartilage and firm enlargement of the right lobe of the thyroid. The basal metabolism rate was −2. A diagnosis of adenoma of the thyroid was made, and on Aug. 17, a hemithyroidectomy was performed, with excision of a right lobe. There was a soft vascular swelling near the median border involving about half the lobe. Within this was a calcified area. Pathological examination showed adenocarcinoma in adenoma. The patient had an uneventful postoperative course and was discharged on Aug. 23, 1937.

She was readmitted on Feb. 21, 1938, complaining of a recurrent nodule on the right side, at the site of the previous lesion. Examination revealed a mass 3 × 3 cm., firm and lobulated, suggesting that it was made up of multiple nodes. Operation on March 1, 1938, revealed a hard mass extending from the stump where the right lobe had been removed into the tissues laterally, and into the sternomastoid muscle posteriorly. Though most of this mass was removed, some neoplastic tissue was left in the region of the stump. On the tenth postoperative day the patient was discharged and referred for radiation therapy. Pathologic examination of the mass showed a histologic picture identical with that of the original specimen.

At the time therapy was instituted several small, stony hard masses were palpable along the right side of the neck in the thyroid region.

The 5-gram radium pack was used, the factors being as follows: distance 6 cm., filtration 0.5 mm. Pt + 5.0 mm. Pb, 8 × 10 cm. portal. Treatment was given to one side of the neck daily for one hour (5,000 mg. hours). Alternate sides were treated between March 10 and April 5, to a total of 50,000 mg. hours to each side. Following treatment a marked erythema developed, but this cleared within a month. During this interval the mass in the right side of the neck became smaller and softer, though there was residual induration.

On May 17, 1938, the patient was readmitted to the hospital and a radium collar was applied. This contained twelve 5-mg., 1.0-mm. Pt tubes with an active length of 2.2 cm. at 2.5 cm. from the skin. This was left on for forty-eight hours, giving a total of 2,880 mg. hours. During the next six weeks there was further reduction in the size of the mass, and the skin reaction reached an erythema and subsided. The radium collar was reapplied as previously for forty-eight hours from June 22, to June 24, 1938. Following this there was gradual disappearance of the indurated mass and by October 1938 there was no evidence of disease. All that remained was a smooth scar. The patient has been seen at regular intervals and has shown no evidence of recurrence or metastasis. When last seen, in September 1943, she reported that she had recently been married and was well and happy.

PROGNOSIS

The prognosis in thyroid carcinoma varies with the histologic structure and the stage of the lesion. The two histologic types which have the best prognosis are fortunately the most common—papillary adenocarcinoma being the most favorable and adenocarcinoma in adenoma second. Pemberton found an over-all survival rate of 77 per cent for operable cases and 29.1 for inoperable cases at three years. The prognosis is, moreover, directly proportional to the classification according to Broders, that for grade 1 being best and for grade 4 worst. According to his group classification, Portmann found 100 per cent of five-year survivals in Group I, 68 per cent in Group II, 23 per cent in Group III, and 3.3 per cent in Group IV. For those receiving postoperative roentgen therapy the corresponding figures were 100 per cent, 65 per cent, 33.3 per cent, and 12.5 per cent. The survival rate among our patients, according to groups, is given in Table IV.

TABLE IV: END-RESULTS IN 64 CASES OF THYROID CARCINOMA

	Stage I	Stage II	Stage III	Stage IV
Number of cases..	3	5	5	51
Known alive under five years.....	..	1	..	..
Survived five to ten years.....	..	..	1	3
Survived ten years or longer.....	1	..	..	2
Known dead.....	..	1	..	32
Presumed dead...	2	3	4	14

SUMMARY

Sixty-four cases of carcinoma of the thyroid seen in the Radiation Therapy Department of Bellevue Hospital since 1923 are presented. The literature of the subject is reviewed, with a discussion of the pathology and clinical picture. A plan of radiation therapy is offered. Three unusual cases are recorded.

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Further Problems in X-Ray Protection

I. Radiation Hazards in Photofluorography[1]

MILTON I. BIRNKRANT, M.D.,[2] and PAUL S. HENSHAW, Ph.D.[3]

THE DANGER of excessive exposure to radiation in the operation of diagnostic roentgen equipment has been pointed out by a number of observers (Braestrup, 1; Bell, 2; Quimby, 3; Taylor, 4; the International X-ray and Radium Protection Commission, 5; the National Bureau of Standards, 6; White, Cowie and de Lorimier, 7). Most of these reports have been concerned with the radiation hazards associated with roentgenoscopy. It is the purpose of this communication, the first of a series of three, to describe the exposure conditions which are more or less typical of photofluorography. Recommendations for the adequate protection of personnel operating photofluorographic units will be included in the third paper of the series.

The radiation hazards associated with the operation of photofluorographic equipment are particularly severe. The volume of work is often large, sometimes reaching 400 to 800 exposures daily. Furthermore, the quantity of radiation per exposure is considerably greater than that in standard chest roentgenography. Finally, the equipment is often portable and installation is of temporary character, circumstances which are conducive to faulty protective measures.

EQUIPMENT

The investigations reported in this paper were conducted with one of the photofluorographic units being used by the Tuberculosis Control Division of the U. S. Public Health Service. The unit included a 200-ma. x-ray machine equipped with a rotating anode tube, with a housing constructed of steel and lined with lead; a lead cone extending from the anode housing limited the primary x-ray beam. Portable V-shaped floor screens containing 1/16-inch sheet lead shielded the operator and positioners. The arrangement of the photofluorograph and protective screens is shown schematically in Figure 1.

Measurements of the quantity of radiation received at various locations about the photofluorographic enclosure were made with a Victoreen ionization instrument employing both 0.25-r and 25-r ionization chambers. Calibration and leakage were checked prior to and during usage, and in most cases a sufficient number of exposures to give at least a half-scale reading were made. It is recognized that there is some question as to the reliability of the readings made with these ionization chambers when radiation of relatively long wave length, such as is customarily employed in diagnostic radiology, is being measured. White *et al.* (7) have investigated this point and have found no serious error in the Victoreen chamber (*i.e.*, no error greater than 10 per cent) in the normal range of x-ray-tube voltages employed in diagnostic radiography.

MEASUREMENTS WITH 35-MM. AND 14 × 17-INCH TECHNICS

To compare the quantity of radiation required for 35-mm. chest photofluorography with that required for ordinary 14 × 17-in. celluloid films, measurements were made by suspending ionization chambers over the chest anteriorly and posteriorly, with the patient standing in the usual position.

With the 35-mm. technic, a series of 8 patients were exposed, their chest diameters ranging from 19 to 26 cm. and aver-

[1] Presented with papers II and III of this series at the Second Annual Staff Conference of the Tuberculosis Control Division, Bureau of States Services, U. S. Public Health Service, Bethesda 14, Maryland, March 29–April 1, 1944. Accepted for publication in October 1944.

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aging 22 cm. The average technical factors were 84 kv.p., 200 ma., 0.2 second, and 38 cm. target-screen distance. The average entrance dose was found to be 0.9 r per exposure and the exit dose 0.015 r per exposure, the latter being 1.6 per cent of the former.

Approximately eighteen times more radiation was thus measured near the entrance skin surface when the photofluorographic apparatus was used than with the standard radiographic technic. In photofluorography with 4 × 5-inch film, where more radiation is required than in the 35-mm.

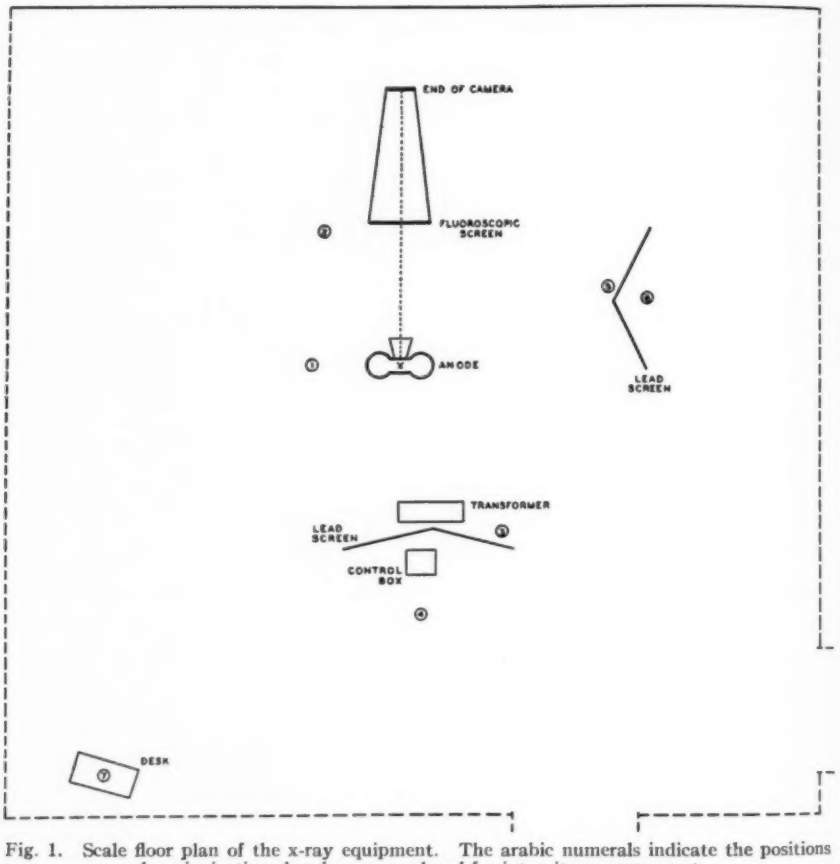

Fig. 1. Scale floor plan of the x-ray equipment. The arabic numerals indicate the positions where ionization chambers were placed for intensity measurements.

To determine the entrance dose for 14 × 17-in. celluloid film technic, 6 patients, whose chest diameters varied from 19 to 25 cm. and averaged 22 cm., were similarly exposed. The conditions in this case were: 56 kv.p., 60 ma., and 0.1 second exposure, the distance remaining the same. The average entrance dose was 0.05 r per exposure.[4]

[4] Exit dose determinations were not made, as the readings were too small to be easily measured.

technic, the differential is undoubtedly greater.

STRAY RADIATION

Ionization measurements to determine stray radiation were also made in the course of routine 35-mm. chest examinations. A limiting cone was in place unless otherwise specified. There was considerable variation in chest diameter in these studies, but the average was 21 cm. Ap-

TABLE I: DISTANCES TO DIFFERENT POSITIONS AND IONIZATION READINGS AT THOSE POSITIONS

Positions* ⟶	1	2	3	4	5	6	7
Inches from center of screen to position	47	22	92	110	61	72	175
Inches from target to position	24	41	48	70	68	75	125
r per 100 exposures with patients	0.25	0.41	0.027	0.001	0.05	0.001	0.015
r per 100 exposures without patients	0.04	0.09	0.008	.....	0.01	.....	.....

* The positions are numbered as in Figure 1.

proximately 4,000 ma. seconds per 100 patients were used at an average tube potential of 81 kv. (peak). The quantities of radiation received at the several numbered locations illustrated in Figure 1 are shown in Table I.

Various figures have been given for the maximum permissible daily dose of x-radiation (tolerance dose) which may be received by technical personnel operating x-ray equipment. The most frequent are 0.1 r per day (National Bureau of Standards, 6; Henshaw, 8, etc.) and 0.2 r per day (White *et al.*, 7; Quimby, 3, etc.). For the purposes of this report we have arbitrarily adopted 0.1 r per day as the maximum permissible dose. The question of tolerance will be discussed in the paper following this (page 569).

The highest radiation intensity, excluding the direct beam, was found just lateral to the photofluorographic screen (position 2), where the accepted permissible dose was exceeded in 25 exposures. It is, therefore, apparent that an operator should not remain near a subject in this location during exposure. Lateral to the tube housing (position 1), a dose of 0.1 r is exceeded after 40 exposures. The fact, therefore, that a so-called ray-proof tube is being used should not give a false sense of security. The locations in front of the two protective lead screens (positions 3 and 5) are also seen to be unsafe, 0.1 r being exceeded after 370 and 200 exposures, respectively. The exposure behind the lead screens (positions 4 and 6) was found to be well within safe limits, some 10,000 exposures being required to produce an accumulated dose of 0.1 r. Position 7, located 10 1/2 ft. away from the anode, where a clerk is likely to sit, was found to receive 0.1 r in 660 exposures. This serves to emphasize the necessity of properly locating non-technical personnel.

To determine whether the person being examined or the x-ray tube was the chief source of stray radiation, roentgen measurements were made (1) with no one before the fluoroscopic screen and (2) with a subject placed in the roentgen beam. Table I shows that the intensity of radiation at positions 1, 2, 3, and 5 increased from 330 per cent to 625 per cent when the subject was interposed before the photofluorographic screen. It is thus apparent that scattering from the patient is the predominant source of stray radiation.

An extension cone attached to the x-ray tube and limiting the primary x-ray beam is of some value in reducing the amount of scattered radiation emanating from the subject under examination. Measurements of radiation intensity were made at positions 1, 2, and 7 with and without the cone in place. The results of this investigation are presented in Table II and indicate that radiation intensities at these locations are 27 to 48 per cent greater when the cone is not present than when the primary beam is limited.

TABLE II: EFFECTS OF EXTENSION CONE

Position ⟶	1	2	7
r per 100 exposures with cone	0.25	0.41	0.015
r per 100 exposures without cone	0.37	0.52	0.019
Increase without cone	48%	27%	27%

CONCLUSIONS

1. Scattered radiation measured near the skin surface was found to be eighteen times greater with 35-mm. photofluorographic technic than with 14 × 17-inch film technic.

2. The subject under examination was

found to be the chief source of scattered radiation.

3. Enough stray radiation escaped in the photofluorographic room during an average working day to give a cumulative dose at several positions where careless operators might stand, which was well in excess of the accepted permissible dose of 0.1 r daily.

4. An extension cone attached to the x-ray tube reduced stray radiation. The increase of scattered radiation without the extension was 27 to 48 per cent in certain locations.

5. The position behind lead screens was found to be the safest place in the room.

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Further Problems in X-Ray Protection

II. Irradiation Injury and the Tolerance Dose[1]

PAUL S. HENSHAW, Ph.D.[2]

THE CONCEPT of tolerance enters into all problems of radiation protection. Numerous articles (1–7), of which the one just preceding (8) is typical, give the amount of radiation reaching persons under various conditions of occupational exposure. In some instances the ratio of primary to secondary radiation is given, and in some estimates are made of the amount of screening material required to reduce the intensity to specified levels. Yet when this careful work is finished, one continues to be faced with the most important question of all: What constitutes a safe dose? It is the purpose of this paper to give a brief history of x-ray protection, to discuss some of the types of irradiation injury, and finally to set forth what appears to be the best attitude toward protection and protective measures at this time.

HISTORY OF THE TOLERANCE DOSE

In a previous report (9) we have traced the history of radiation protection as follows:

". . . as early as 1902 attention was given to the question of how much radiation a radium or X-ray worker can withstand. At that time the suggestion was made by Rollins [10] that 'if a photographic plate is not fogged in seven minutes, the radiation is not of harmful intensity.' Although it was known within a few months after the discovery of X-rays that this radiation is more effectively stopped by lead than by most other materials, and as early as 1903 that scattered radiation existed [11], there is no record of further work on protection for a period of thirteen years despite the fact that many cases of radiodermatitis and radiocarcinoma continued to accumulate. . . .

"What was believed to be the first organized step toward protection from roentgen rays was taken in 1915 following the reading of a paper on protective devices before the British Roentgen Society [12]. At that time a resolution was passed providing that the council of this society should meet and take steps toward securing safety for X-ray operators. Because of the war activity which existed then, the plan failed to bring forth important advancements. As the result of the war demands, caution gave way to action and protection measures were again forgotten. The taking of increased risks at this time probably was a factor which contributed to an unfortunate development in 1919 and 1920, both in this country and in Europe, when a number of prominent radiation workers died of apparent irradiation injury, particularly aplastic anemia. Unfavorable publicity developed and action resulted.

"While some steps toward protection were taken in France immediately after the war, the first roentgen protection committee was formed by the American Roentgen Ray Society in September 1920. Following the publication of certain terse comments in the *London Times* in March 1921 concerning the sad plight of X-ray workers, the British X-ray and Radium Protection Committee was formed. The British committee presented its first recommendations in July 1921 [13], and the American committee made some suggestions for protection in September 1922 [14]. The two sets of recommendations were much the same in substance, protection being dealt with chiefly from the standpoint of absorptive screening and distance. . . .

"From the point of view of safety, it is interesting that the early committees (1920–21) recognized merely 'visible injuries to the superficial tissues, derangements of internal organs and changes in the blood' as injurious effects to be guarded against [13]. While 'derangements of internal organs' is indefinite, it is known that damage to the reproductive organs was an effect about which there was considerable concern.

"The next important development was an attempt to ascertain some estimate of the limit to which an individual could be exposed to radiation without sustaining noticeable injury—in other words, to find the 'tolerance dose.' The procedure followed by a number of investigators was to formulate some kind of quantitative evaluation of the amount of radiation (usually X-rays) reaching persons who had worked with the agent for a number of years and remained in good health, no distinction being made between local and general body exposures. The accumulated results are shown in Table I. Up to and including 1928, the tolerance doses were expressed in terms of erythema doses but these can readily be changed to roentgens by multi-

[1] One of three papers accepted for publication in October 1944.
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TABLE I: TOLERANCE INTENSITIES RECOMMENDED BY DIFFERENT AUTHORS

References	Date	Erythema per Month	r/Day
Mutscheller (15)	1925	0.01	0.2
Sievert (16)	1925	0.01	0.2
Glocker and Kaupp (17)	1925	0.01	0.2
Solomon (18)	1926	0.1	2.0
Dutch Board of Health (19)	1927	0.002	0.04
Barclay and Cox (20)	1928	0.0084	0.168
Bouwers and van der Tuuk (21)	1930	0.01	0.2
Failla (22)	1932	0.001	0.02

plying by 600. . . . It should be mentioned, also that the results were based on a very small number of individuals in each case, from two to 'a very limited number' [15], thus causing the findings to have limited reliability.

"Kaye [23] in 1928 referred to the works of Mutscheller, Sievert, Solomon, Dutch Board of Health, and Barclay and Cox, and adopted 0.12 r per day (0.001 erythema dose in 5 days) as an intermediate value. In 1928 the question of protection from X-rays and gamma rays came before the second International Congress of Radiology for consideration and action. In view of the fact that the recommendations in use in England were generally adopted by the Congress, it is clear that Kaye's tabulation on tolerance dose must have influenced the steps that were taken. It should be noted, nevertheless, that the recommendations [24] adopted by the International X-ray and Radium Protection Commission, which were set up in 1928, contained no reference to tolerance dose, merely stating, as had been done in 1921, that the known effects to be guarded against were: '(*a*) injuries to the superficial tissues, (*b*) derangements of the internal organs and changes in the blood.' Likewise the Commission's report [25] made in 1931 contains no statement in regard to the tolerance dose, although in the subsequent reports, 1934 [26] and 1937 [27], this dose is tacitly stated as being 0.2 r per day.

"As an outgrowth of the International Commission there was formed in the United States an Advisory Committee on X-ray Protection [28] to deal with particular problems in this country and draw up recommendations. This committee published its first proposals [29] in 1931, in which the tolerance dose was set forth as 0.2 r per day, thus being in general agreement with Kaye's estimated figure given in 1928. In a later report in 1936, which is the last [30], the tolerance dose is stated as 0.1 r per day, no explanation being given for the change. In a recent publication on the subject of radiation protection, Taylor [31] referred to the safety value as being 0.02 r per day, a still smaller figure, but one which is in agreement with that recommended by Failla [22] in 1931."

From the foregoing paragraphs, two points are clear: first, that the present generally accepted safety dose of 0.1 or 0.2 r per day is based on very crude data; second, that the effects for which protection is needed have been only vaguely defined. This remarkable disregard of the nature of irradiation injury may be understood when it is realized that the protection committees have for the most part been in the hands of physicists, and that it is by them that practically all of the papers dealing with protection have been written. While it is recognized that the regulation of radiation intensities lies properly in the province of physics, it should be equally recognized that determination of the tolerance dose, if indeed there be a tolerance dose, belongs to the province of biology and medicine. In this paper we shall attempt to deal with the subject from a biological point of view.

TYPES OF IRRADIATION INJURY

Dermatitis and Carcinoma: Dermatitis is a type of injury commonly following exposure to radiation. This effect will result either from acute or protracted exposures when sufficient dosage is administered. If the damage is not too severe, normal healing usually ensues. When the ulceration is deep, healing often fails to occur or is abortive. Granulation tissue in such areas acquires a chronic character and furnishes a poor tissue bed for epithelization. Epithelial edges show little or no lateral extension and the sheets become thickened, often producing downgrowth and in some cases carcinoma. The latter is a late complication and probably is associated more with the chronic character of wounds than with the direct action of radiation (32).

A systematic examination of histologic changes in the skin of animals following mild irradiation injury (33) discloses that the first cells to disintegrate and disappear are those of the stratum germinativum, an effect usually occurring within a few days after treatment. If the destruction of this layer is extensive, ulceration follows and the maximum effect is reached usually in two to three weeks. Open ulcers appear

to result from failure of the stratum germinativum to replenish the cuboidal cells, which are transformed into squamous epithelium and lost. The underlying connective tissue in such wounds usually shows a mild inflammatory reaction and some loss of vascularity. The acute reaction may subside fairly promptly, but evidence of mild irritation may persist longer than in the case of traumatic wounds. During this phase, blood vessel repair is slow and sometimes abnormal, giving rise to telangiectasia and to obliterative changes.

It is significant that desquamation without ulceration may follow smaller doses of radiation. In such instances only part of the germinal cells appear to be destroyed, resulting in a momentary break in the continuous process of skin formation. After a brief desquamation, new squamous tissue arises in the floor of the wound from remaining germinal cells.

From the foregoing, it is apparent that an appreciable amount of radiation must be administered to the skin before ulcers can be produced. For such effects, then, there are threshold dosage levels.

Sterility: Injury to the reproductive organs and tissues in all probability ranks first in importance in the minds of those who are aware of occupational exposure to radiation. Evidence of temporary sterility has commonly been observed in man after applications of several hundred r to the reproductive organs either therapeutically or occupationally. Apparent complete sterility has likewise been produced, but the dosages required vary widely from one individual to another and also with the method of administration. The production of sterility, like the production of skin injury, can best be understood by referring to experiments with animals.

Progressive changes in the mouse testis following different doses of x-rays have recently been described (33). In the seminiferous tubules, the germinal elements are arranged for the most part in the order of maturation. Passing from periphery to lumen, one finds spermatogonia, primary spermatocytes, secondary spermatocytes, and sperm. The fact that each of these types can be identified histologically and the further fact that the various elements move inward as maturation progresses aid greatly in investigating the steps involved in irradiation injury of the testis.

The following changes have been observed after acute doses of 100 r applied to the whole bodies of mice. During the first two or three days only a faint cloudy swelling in the parenchymatous tissues can be seen. At four days to one week, a reduction in the number of primary spermatocytes is noted. This is followed by a slow return to normal without other conspicuous changes. With smaller doses, germ cell loss is slight or absent, but with doses of 200 to 400 r the changes are extensive. Loss of primary spermatocytes takes place, as with 100 r, at four days to one week, but the loss is more extreme, being in fact nearly complete in most instances. In addition, there is loss of many or all spermatogonia. Absence of the more primitive elements is followed at two to three weeks by disappearance of secondary spermatocytes and sperm. At three weeks after exposures to 400 r, the tubules appear almost empty. Regeneration usually takes place, however, as long as some primordial cells survive. If regrowth occurs, the reappearance of cell types is in the order of germ cell maturation. First, a bead-like row of spermatogonia develops around the periphery of the tubules; next, spermatogonia and primary spermatocytes are seen together; still later the full complement of germinal elements, including sperm, is seen.

The general reaction can be pictured as follows. The destructive action of radiation is mainly on the primordial cells in the testis, as it is in the skin. The fact that an interval of several days occurs between the loss of primary spermatocytes and the appearance of secondary spermatocytes suggests again that the loss of mature elements is due more to maturation and failure to replenish the losses than to direct irradiation injury. Temporary sterility appears

to result from partial loss of primordial elements, and permanent sterility from complete loss. Since evidence of early germ cell destruction may be seen in animals that receive less than the dose required to produce temporary sterility, it is plain that functional sperm may be produced in the presence of partial irradiation damage. Hence, although the threshold destructive dose for certain immature germ cells may be relatively very low, that for the functional organ may be high. In any case, it is plain that there are dosage levels below which sterility will not be produced.

Anemia and Leukemia: Connective-tissue cells in mammalian organisms comprise a complex and important series of cellular elements having important roles in metabolism, immunity, repair, and other functions. Embryologically the various connective-tissue elements arise from the primitive mesenchyme, making it plain that the different blood elements, as erythrocytes, granulocytes, lymphocytes, and megakaryocytes, have a common origin. In normal hemopoiesis, however, different blast forms serve as the parent types for the various blood elements, the mesenchyme as a rule not functioning as hemopoietic tissue. Mesenchyme cells give rise, also, to cartilage, bone, fat, and fibrous connective tissue, but not only are these elements less sensitive to radiation but changes in them have less significant physiologic consequences in the organism. Thus, while the blood and other connective tissues may be closely related from the standpoint of origin, we shall here be concerned only with the blood and lymphoid organs—the reticulo-endothelial system.

The reticulo-endothelial system taken as a whole can, because it forms new cells continuously throughout life, be spoken of as a generative organ in much the same manner as we have spoken of the skin and testis as generative organs. Perhaps the most significant difference, so far as this discussion is concerned, is that the reticulo-endothelial system elaborates a variety of cell types instead of only one. As we shall see, the developmental relationship and length of life of these various cell types are of importance in dealing with the injurious action of radiation.

When whole body x-ray irradiation is administered to mice, changes in the reticulo-endothelial system are manifested in a variety of ways. Alterations in the peripheral blood may be observed after exposures as low as 50 r. During the first two to four hours after treatment, a slight rise in leukocyte (both neutrophil and lymphocyte) level is manifested. Within eight to twelve hours, however, this changes to a leukopenia, which may persist as long as two weeks or more (36). Differential cell counts disclose that the leukopenia is due mainly to lymphocyte loss. When doses in the range of 5 to 15 r are administered, some evidence of leukocytosis without subsequent leukopenia is obtained. On the other hand, larger doses (200 to 400 r or above) produce evidence of leukopenia without initial leukocytosis, the fall being due to loss of both lymphocytes and neutrophils. Recovery to the normal range occurs, as a rule, in four to eight weeks, if the damage has not been too great. After repeated application of doses of 200 or 400 r, a condition of chronic leukopenia develops. Acute doses of 800 to 1,200 r produce a severe leukopenia within a few hours, and the result is usually fatal within a week or ten days.

It has not been possible, of course, to observe in such detail the changes which take place in human beings. It is known, nevertheless, that in radiation workers who are occupationally exposed to small amounts of radiation daily persistent leukopenia develops, varying from the normal range to levels of 3,000 cells per cubic millimeter of blood or lower, depending on the amount of exposure (37). In such cases the lymphocytes show an increase or a decrease in number depending on the stage to which the injury has progressed. In some cases there is a shift to the left in the differential count, more than the usual number of myelocytes and blast cells being present. Of particular interest are those persons who

show only mild changes and remain in an apparent state of good health. Whether their ability to resist disease and carry out other physiologic activity is impaired is not known.

The histologic changes in mice following comparatively small doses (50 r) are mild but distinct. Nuclear fragmentation and necrosis of cells in the lymph nodes and spleen may be seen within two to four hours after acute exposure of the whole body. At six to twelve hours the cellular debris is accumulated in small clumps, presumably by macrophage cells. At twenty-four hours, all evidence of cellular debris has disappeared, leaving a picture practically indistinguishable from the normal. When doses of 200 to 400 r are administered, the cellular disintegration is more extensive and the clumps of necrotic material at six to twelve hours are more numerous. Again the debris is cleared in twenty-four hours, but in this case there is a noticeable loss or apparent absence of small lymphocytes, leaving a solid mass of reticular tissue. Reappearance of lymphocytes takes place slowly, and at six weeks it is usually difficult to distinguish irradiated from normal tissues. Following still larger doses, destruction of reticular tissue as well as lymphocytes occurs. In these cases, the power of regeneration is impaired and a condition of aplasia may develop.

Loss of cellular elements takes place in the bone marrow as in the lymphoid organs, but with certain variations. Cellular debris and accumulation of destroyed cells are not seen—only thinning of cellular elements. Because of the rigid character of marrow spaces, sinuses develop as the cells disappear. Since the cells which remain show a greater proportion with ring-shaped nuclei, the loss may be regarded as resulting mainly from the destruction of younger forms. Only slight evidence of bone marrow loss can be detected in mice receiving doses of 50 r, but the marrow spaces become practically devoid of cellular elements following 400 r. Recovery of this tissue likewise ensues in a period of four to eight weeks, if the destruction has not been severe. Such tissue changes may take place with little or no change in the erythrocyte level of the circulating blood.

The action of radiation on the reticuloendothelial system may be summarized as follows. Radiation acts alike on the cells of the peripheral blood and hemopoietic organs, causing nuclear fragmentation and cell death. This appears to be true irrespective of the size of dose, very small doses producing damage of so slight a degree as to go undetected by the usual means. Small lymphocytes are the first to go, with neutrophils and blast forms following close after. Reticular cells are comparatively much more resistant, and erythrocytes are usually little affected even by excessive exposures. The lack of effect on the erythrocytes may be explained as follows. Since their life is relatively long and the regeneration of bone marrow rapid, it would appear that the latter is able, even after considerable damage, to regenerate fast enough and resume hemopoiesis quickly enough to avoid the development of significant anemias. Also, it seems plain that, in the case of prolonged exposure, the rate of hemopoiesis may be greatly increased if necessary to compensate for continuous heavy loss of hemocytoblasts. The sudden and marked leukopenias may be explained on the basis of the short life of the leukocytes and the fact that, irrespective of location, they appear to be destroyed outright by radiation. In this case leukopenia appears to develop as soon as the leukocyte reserve has been exceeded. A single dose of 50 r applied to the whole body of a mouse has been found adequate to destroy this reserve.

The foregoing observations pertain to relatively acute effects. They are, however, in part, true of the changes which precede the later complications of aplastic anemia and leukemia. The first of these complications appears to develop when the damage to germinal elements has become so severe that satisfactory regeneration cannot occur. Numerous cases of aplastic anemia have been seen in human beings as well as in animals after excessive exposure

to radiation. The second develops coincident with or as a result of the regenerative growth which takes place. A number of experiments are now on record (38–41) showing that the incidence of leukemia in mice can be appreciably increased by whole body exposures to x-rays, and there is one report (42) indicating that in human beings the incidence of leukemia is higher among physicians than among the general population. It does not follow from the latter observation, of course, that radiation was the contributing agent, but since physicians as a group are exposed more to high-energy radiation than the general population, the observation is in accord with the experimental findings in mice.

We may now return to the matter of developmental relationships in connective-tissue elements. If reticular tissues represent the most primitive mesenchyme of the hemopoietic tissues, and the free lymphocytes an intermediate stage between the reticular tissue and the variety of more advanced forms, it would appear that in the skin, testis, and reticulo-endothelial system the parenchymatous cell loss results from two general causes: destruction of primitive cells by the direct action of radiation and loss by further maturation of cells which cannot be replenished. Further, since free lymphocytes are more easily destroyed than the reticular cells, the response in the reticulo-endothelial system is similar to that in the testis, as the most primitive cells are more resistant than those slightly more advanced in development. More careful studies of the skin may reveal that the intermediate stage in this organ is also more radiosensitive.

Mutations and Genetic Injury: The discussion to this point has dealt entirely with tissue or organ changes following exposure to radiation. Since tissue changes result largely from cell changes, it is important to consider the nature of cell changes as well. In 1927 it was first shown that the genetic constitution of a cell can be altered by ionizing radiations (43). The first experiments were carried out on the fruit fly, *Drosophila melanogaster*. Adult males previously exposed to radiation were allowed to inseminate normal virgin females. Offspring obtained from such matings were examined for abnormalities and a considerable number of individuals were found which showed unusual characteristics. Similar results were obtained when ova were irradiated instead of sperm. The changes were of the most diverse types. Some involved eye color, shape of wings, number of bristles, etc., some early development, and still others the first mitotic division after fertilization (44). Since such modifications become fixed in the germ plasm and are passed from parent to offspring through succeeding generations, they are properly termed "mutations." Various cytologic and genetic studies (45–47) have revealed that the cell alterations which give rise to mutational changes consist of chromosome alterations in the form of deletions, translocations, or inversions, and also of gene modifications. Extrachromosomal changes which affect the host organism or even the genetic line may also occur, but it has not been determined whether such changes are of significance or are transmitted indefinitely.

The mutational changes observed in *Drosophila* were induced in germ cells which carried the alterations into the zygote. These alterations were then passed from one cell to another in the developing offspring until finally the new characters were manifested in the adult stage. Some changes induced in this manner occur earlier and cause abnormalities in development or in early cleavage (48–50). When the cell modifications are incompatible with life, and death results, the original chromosomal or gene changes induced by the radiation are "lethal mutations." Abnormal cleavage usually results in early death of the cell or its progeny after a few additional divisions. When the lethal change occurs in the zygote or early cleavage stages of an oviparous animal, the cells simply disintegrate and disappear into the surrounding medium; when they occur in viviparous animals, the embryo is either absorbed or aborted. Changes hav-

ing less immediate effects may result in monster formation, death not occurring until late in development or even after birth.

Radiation-induced mutations may occur in somatic cells just as they do in germ cells (51), but the consequences are very different. If exposure occurs during early embryonic life, the abnormalities produced may be similar to those resulting from injury to the germ cells. If, on the other hand, exposure occurs late in life, somatic cell mutations are not likely to have significant consequences, that is, unless the cells become endowed with powers of unlimited growth. Indeed, this explanation of cancer has not yet been entirely disproved.

Considerable attention has been given to the dose-effect relationship in the induction of radiomutational changes in *Drosophila*. It has been found by numerous investigators (see 52 and 53 for summary) that the reaction is typical of the mass-action law. This suggests that the reaction has no significant threshold and that there is no dose below which mutational changes will not be produced. As will be shown later, the implications of these findings have considerable bearing on the question of tolerance.

Shortening of Life Span: Although it has long been known that radiation may produce lethal changes and that the length of life following exposure will vary in a general way with dosage, there has been no systematic attempt to study this relationship until recently (54). Daily doses of 5, 10, 15, 20, and 25 r were administered acutely to the whole bodies of mice five times weekly, from the age of three months until death. It was found that the length of life varied progressively in an inverse relationship to the size of the daily dose, even the animals receiving the smallest daily treatments showing some reduction in longevity. The most appealing explanation of this reaction is that the regenerative capacity of cells is progressively depleted until a point is reached where the organism is unable to regenerate enough cells to sustain life. In such a case, one would expect to find in the tissues at death about the same degree of destructive changes, irrespective of the size of the daily dose. Histologic studies, however, disclosed that the amount of tissue injury was not uniformly the same in the different animal groups, but rather that it tended to vary directly with the size of the daily dose. Whether the length of life is shortened by daily exposures of 1.0 r or 0.1 r has not yet been ascertained, although extrapolation of the curves suggests this as a possibility.

DISCUSSION

Several of the more distinct types of roentgen injury have been described, and in a few instances the amounts of radiation required to produce various effects have been given. It is plain from the statements made, however, that the detailed nature of radiation injury in mammalian organisms is as yet very incompletely understood, and also that relatively little is known regarding the threshold doses required to produce the effects now recognized. Under these circumstances, it is difficult to deal with the question of tolerance. Yet in practice, where decisions must be made, it is necessary to examine the facts and formulate opinions based on the most probable results. We shall now consider some of the underlying problems involved.

Threshold vs. Non-threshold Reactions: From the evidence at hand, it seems clear that for irradiation-induced changes such as skin ulceration, sterility, and aplastic anemia, there are threshold dosage levels—that is, levels below which such changes are not produced. In this type of reaction one can speak with full justification of tolerance doses, even though the actual amounts of such doses are not precisely known, and rightfully maintain the attitude that a person will be entirely safe if exposures do not exceed these amounts. On the other hand, for changes such as gene mutations, chromosome aberrations, and the outright killing of cells, there is a fair body of evidence indicating that threshold levels do not exist. In such reactions, the effect

appears to result from an all-or-none single-event type of action, such as the bullet-like encounter of an energy quantum with a vulnerable spot in the cell. Thus, for any increment of dosage there must exist certain chances of cell death, the frequency of which varies directly with the dose. In such instances it seems more proper, as we have suggested before (8), to think in terms of "tolerance injury" rather than "tolerance dose." The expression "tolerance injury" implies correctly that acceptance of any tolerance dose, in the case of non-threshold reactions, is entirely arbitrary and based on the amount of injury one is willing to endure. Realizing that certain chances of genetic modification exist so long as any exposure occurs, the procedure in planning tolerance doses would consist simply in deciding on the degree of risk one is willing to accept and the regulation of exposures accordingly. Such procedure would indeed be reasonably simple if information were available concerning the kinds of mutation that occur and if the frequency of occurrence with respect to various increments of dose were known.

Frequency of Mutation: It has been shown (55) that for a particular mutation in *Drosophila* which occurs spontaneously in approximately one of every thousand germ cells, the frequency of occurrence is practically doubled by doses of 35 r of x-rays. In other words, the frequency of mutation is increased from one in one thousand to two in one thousand by such a dose. Assuming that genetic injury in human beings might occur at a similar rate, the remoteness of such injury might appear to be so great as to have little significance, since nearly a year would be required to accumulate a dose of 35 r at the rate of 0.1 r per day. The probability of mutation may, however, not be so remote. In the first place, the figure for *Drosophila* pertains to only one kind of mutation, when actually a great variety of types exist, any one of which may have a frequency of occurrence equal to or greater than that for which the figure was given. Of greater importance is the fact that genetic modifications appear to accumulate not only during the lifetime of an individual (before reproduction) but through succeeding generations. In this way the long-term aspects of the problem become of particular interest.

Whether genetic injury is accumulating more rapidly in human beings exposed to radiation than in those not so exposed is not known, although a few figures suggest this possibility. A questionnaire was circulated among radiologists some years ago by Hickey and Hall (56), requesting information pertaining to the amount of preconception irradiation injury shown in the offspring of radiation workers. These authors stated that of the 377 couples investigated (usually only the husband coming in contact with radiation), 36.6 per cent were sterile. This figure may be compared with 19.7, which is the percentage of white women 15 to 75 years of age (married and unmarried) shown by the 1940 census (57) to be childless. Hickey and Hall stated further that, of the 262 children born to radiologist couples before radiation employment, 2.6 per cent showed some form of abnormality, whereas of the 412 born after such employment, 4.0 per cent showed abnormalities. Among the child-bearing couples, the average number of children per family was found to be 2.2 as compared with 3.0 for other physicians and surgeons living in comparable circumstances. Naujoks (58) made a study of 91 x-ray workers and found the percentage of sterility to be 24.2 per cent, the incidence of abnormalities to be above normal, and the proportion of developmental defectives to be about 4 per cent. Taken as they stand, these results suggest that preconception irradiation injury is already showing in the offspring of human beings. Since, however, so many hazards are associated with the collection of this type of information, the implications arising therefrom must be accepted with considerable reservation.

Attitude to Be Taken Regarding the Tolerance Dose: Confronted thus with evidence that for certain types of injury there is no safe threshold of exposure, what atti-

tude should be taken toward the exposure of healthy persons to ionizing radiations? What significance does the present standard of 0.1 r per day have? There are those who fear that 0.1 r per day is a dangerous level of exposure and urge that the permissible exposure be lowered to 0.01 r per day, or to zero if possible. This view is prompted largely by the fact that mutational changes are believed to result in weaknesses rather than in strength and the feeling that a general racial weakening may ensue. There are others who point out that zero exposure can never be obtained, since our bodies are continually subjected to earth and cosmic radiations at the rate of approximately 0.001 r per day. Dropping the present standard by a factor of 10 leaves only a factor of 10 difference between the proposed new standard and the level of exposure to which man has been subjected during his entire evolutionary development. Reasoning thus, one has a tendency to regard lowering of the safety standard by a factor of 10 as being somewhat absurd and to assume an attitude of indifference. A few figures at this point are illuminating.

It has been pointed out by Martland (59) that 1.0 microgram of radium distributed throughout the body of a human being will have fatal consequences in five to fifteen years, by Rajewsky (60) that 0.1 microgram will have a distinctly deleterious though not fatal effect, by the U. S. Bureau of Standards Handbook (61) that 0.01 microgram is considered the tolerance limit in the human body, and by Krebs (62) that the average human body in middle life contains approximately 0.001 microgram of radium (the figure actually given by Krebs was 7.5×10^{-9} grams). Thus, in a general way there appears to be a factor of 10 difference between the lethal level, the injurious level, the tolerance level, and the normal level. These remarkable figures reveal perhaps more clearly than ever before the comparatively narrow range of radiation exposure compatible with life and emphasize the care required in regulating the permissible exposure.

The limits of the protection problem are thus well bracketed. It is plain that some exposure will take place despite all that man can do to prevent it and further that, if the exposure exceeds certain levels, death will result. Where then does the present standard of 0.1 r per day lie on this scale? From a fairly broad background of experience, there is evidence that this amount of exposure will not produce skin ulceration, sterility, or dangerous blood changes. Whether such exposure will contribute to premature aging or how much it will increase the frequency of mutation is not known. On the basis of the figures just presented, there appears to be a factor of approximately 100 difference between the normal amount of radium in the body and the injurious amount. It would be interesting to transform the radium exposures into roentgen doses in order to compare radium and x-ray doses directly. Such a transformation, however, involves so many uncertain assumptions that little significance could be attached to the figures obtained.

Some impression of the roentgen picture, nevertheless, may be gained by piecing together various facts. From the evidence presented, it is plain that 10.0 r per day applied to the whole bodies of mice appreciably shortens their life span, and from extrapolation there is reason to believe that daily exposures of 1.0 r per day may have injurious effects. The effects obtained with these exposures, then, may be considered comparable to the lethal and injurious radium exposures, respectively. The permissible dose of 0.1 r per day of x-rays, which is a factor of 10 less than the injurious dose, would be comparable to the accepted tolerance limit for ingested radium. As indicated above, the level of natural earth and cosmic radiations (0.001 r per day) is only a factor of 100 lower. But in addition to the earth and cosmic radiations, our bodies are continually subjected to the radiation coming from the small amount of ingested radium, which tends to reduce this figure of 100. Thus, on the basis of the figures given, which in-

volve the assumption that the effects in mice and human beings are generally comparable, there is some justification for believing that in the case of x-rays, also, there is roughly a factor of 10 difference between the lethal level, the injurious level, the permissible level, and the normal level. Let it be understood, however, that while these figures may be the best that can be brought forward at this time, they must be considered as exceedingly rough approximations. They serve only as a working guide, suggesting that a factor of 10 difference in exposure to ionizing radiations may have significant biologic consequences.

But irradiation injury is a practical problem. Certain practices must be followed while further knowledge is being obtained. From the figures just presented, it is plain that 0.1 r per day lies intermediate to the normal and lethal irradiation exposures in a range which might reasonably be expected to be safe. Under these circumstances and while the safety problem is being studied, it would seem most expedient to continue with the present standard of 0.1 r per day until good reason is obtained for changing. Certainly an open-minded attitude should be maintained, for, as shown repeatedly in the discussion above, there is reason to believe that some injury may be produced by continuous exposure to 0.1 r per day.

This attitude ignores completely the non-threshold types of injury. At the present stage, however, this seems the only thing to do, for three reasons: (1) It is plain that there is no possible way of avoiding radiation completely. (2) It is not known whether exposures of 0.1 r per day increase the rate of mutation significantly. (3) It is not yet proved that the mutations caused by radiation are predominantly injurious. Regarding the latter, the great concern over long-range racial weakening does not seem entirely justified. Granting that evolution takes place in part by means of mutation and that radiation may increase the frequency of mutation, it does not follow necessarily that all or even most of the mutational changes will be detrimental to the race. It is important to keep in mind that all living things, including man, have risen to their present evolutionary level despite constant exposure to ionizing radiations coming from earth and cosmic sources. Hence, while it is recognized that radiation can and does cause serious genetic abnormalities and that some of these may contribute to weakness and be perpetuated indefinitely, one must conclude that there are factors not yet fully recognized which act to counteract the accumulation of injurious effects.

All things considered, it would seem that 0.1 r per day is a reasonable safety level of exposure despite its humble origin. This would appear to be true especially for the familiar threshold types of injury and, on the basis of very fragmentary knowledge, to represent a reasonable risk in the case of non-threshold type reactions. Hence, for the time being, it would appear that efforts should be devoted more to maintaining the adopted standard than to changing it. However, in view of the fact that information regarding irradiation injury is accumulating rapidly, the advisability of making some kind of change should continually be kept in mind.

SUMMARY

The problem of radiation protection has been reviewed.

It has been recognized (1) that various effects, such as skin ulceration, sterility, anemia, and even death may result from exposure to ionizing radiation in amounts not greatly exceeding those which accumulate in comparatively short periods of time in various laboratories, shops, and clinics; (2) that for such effects there are threshold levels of exposure; (3) that other changes, such as premature aging and neoplasia, may appear long after exposure; (4) that for still other effects, irradiation-induced mutations, there appears to be no threshold level of exposure; (5) that there is roughly a factor of 100 difference between the accepted permissible dose of 0.1 r per day and the cosmic and earth radiation to which everyone is continuously exposed;

(6) that slight changes in the blood picture can be found in apparently normal persons exposed occupationally to small amounts of radiation.

The feeling is expressed that in the absence of more complete information, every effort should be made to prevent exposure intensities exceeding the present accepted permissible level of 0.1 r per day and that an open mind should be maintained toward the necessity of lowering the present level if this is indicated by future developments.

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Further Problems in X-Ray Protection

III. Protective Measures in Photofluorography[1]

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IN VIEW OF THE necessity for protection against stray radiation in photofluorographic units (1, 2), the Tuberculosis Control Division of the U. S. Public Health Service has developed a program of personnel protection which is herein described. In addition to the provision of adequate protective equipment, measures had to be taken to see that such equipment was properly used and that needless exposure was avoided. In doing this it was necessary to take into account the human factor of heedlessness and to see that operators had to take precautions whether or not they wished to do so. These steps having been taken, it was considered essential to determine by physical means whether the protection provided was adequate. Further, in view of the shortcomings of the accepted permissible dose, it was considered advisable to check workers for evidence of injury. It is believed that this program will provide not only the best possible protection but will yield much needed information concerning the problems of exposure and injury.

PROCEDURES

Location of Equipment: Since the photofluorographic equipment in use is of portable type, operators are directed first of all to give attention to its location and arrangement. Airy, spacious rooms, 18 × 20 feet or larger, are desirable. The equipment should be so arranged that the x-ray beam is directed toward an outside wall, preferably toward a window. The x-ray machine should be at least 8 to 10 feet from side walls in order to reduce reflected radiation and provide adequate freedom of movement of patients and operators.

Alignment: Operators are instructed to check alignment with 14 × 17-inch films as described in the first paper of this series (p. 565). In order to keep stray radiation at a minimum, the primary x-ray beam should be limited strictly to the field of the fluoroscopic screen. Such beams can be obtained by properly adjusting the position and angle of the extension cone.

Unnecessary Primary Radiation: Some primary radiation escapes through the x-ray tube housing but, as shown in the first paper, this is not the most serious source of stray radiation. Occasionally "leaks" occur in the tube housing due to faulty construction, failure to keep all parts in place, etc. Operators are asked to check for leaks with films and to explore the field around the tube in order to know where the intensity is greatest. Holes in the tube housing should be covered with lead (or other adequate absorbing materials) and the beam of primary radiation confined strictly to the area of the fluorographic screen. The fact that a so-called "ray-proof" tube is being used should not lead to a false sense of security, as the lead housing of such tubes is intended to do no more than cut the escaping radiation to a reasonably safe level. Some idea of the quantity and quality of radiation that will escape from ray-proof tubes operated under a variety of conditions has been given recently in a paper by White, Cowie, and de Lorimier (3). From the measurements made with and without the patient in place in front of the fluorographic screen, it was found that the chief source of stray radiation for the usual working conditions was not the tube but the patient (70 per cent). Hence, while it was recognized that a por-

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tion of the stray radiation was of primary character, escaping through the tube housing, this component was considered of minor significance and nothing further was done about screening in the immediate vicinity of the tubes.

Protective Screens: Since the stray radiation from all sources was found by measurement to be several times more than 0.1 r for the average working day at various locations where a technician might stand during exposure, lead screens (1.5 mm. thick) were provided. Workers were asked to arrange these so as to shield themselves from radiation coming both from the tube and the patient. Doses received behind the screen have been found by measurement to be well within permissible limits, even for the heaviest daily schedules. Such equipment was provided, however, before it was known that the patient was the chief source of stray radiation. When it was realized that the character of this radiation was necessarily "soft," it became obvious that such heavy lead screens were unnecessary to reduce exposures to the permissible levels. The effective wave length of the stray radiation at a position lateral to and about 1.5 feet from the fluoroscopic screen was measured and found to be approximately 0.3 Å. Hence, since it was necessary for our screens to reduce the intensity no more than five-fold, it became apparent that lead 0.1 to 0.2 mm. thick or iron 0.7 to 1 mm. thick is theoretically sufficient for this purpose.

The Human Factor: Screens having been provided, the next problem was to see that they were used and used properly. In an effort to save the split second necessary to get fully behind the screens, or through indifference or unawareness, technicians often hold their heads and a portion of their bodies behind the screen, leaving the remainder of their person exposed (or *vice versa*). So far as certain types of injury are concerned (2), it probably makes little difference which part of the body is irradiated. For this reason, workers are advised never to so much as rest a hand on the outside of a screen during exposures.

In order to protect operators, including the indifferent and careless, the control switch is rigidly fixed in the middle of the rear side of the operator's screen. Similarly, when a positioner makes up part of the working team and a second screen is used, a foot switch (arranged also in the primary circuit) is located behind this screen. Thus, both workers must be in place behind their respective screens before an exposure can be made.

The Secretary's Desk: As pointed out previously, a person seated at a desk within a radius of 10 1/2 feet from the patient will accumulate radiation which exceeds the permissible level after 600 to 700 exposures. Hence, a screen is also provided for the secretary, or her desk is placed at a greater distance or behind either the operator's or positioner's screen.

Determination of exposure conditions by taking repeated and usually closely spaced photofluorograms of some convenient member of the staff has been found often to be a common practice. In a single 35-mm. photofluorographic exposure the subject has been found to receive 0.9 r on the entrance surface, which is more than the permissible dose for an entire week. It is recommended that an aluminum ladder (Weyl, Warren, and O'Neill, 4) or a copper step tablet (Weidman and Kieffer, 5) be used for calibration purposes. Actually such devices should provide even more satisfactory calibrations than the use of human subjects. If photofluorograms of an aluminum or copper scale are taken with equipment which has been standardized and is giving satisfactory results, the films may be used for checking the same equipment or for calibrating new equipment. It is recommended that wire mesh be used for focusing the camera, and lead numbers for centering the primary beam. This source of needless exposure of human subjects to radiation may thus be eliminated entirely. If, however, calibrated films and other material are not available and a human subject must be used, it is better practice to use patients, as they will not be subjected to repeated exposures.

Actual Exposure of Personnel: The distribution of radiation in an x-ray room, is not always as expected. Unsuspected factors may act to change the intensity of exposure at different locations. Furthermore, technicians do not always follow instructions designed for their own protection. Hence, it was considered necessary to measure the amount of radiation reaching each technician. This is being done by means of photographic films. Once per month each worker is supplied with a dental film from a common stock. This he is instructed to carry on his person for a period of seven days, at the end of which time he writes his name, together with the inclusive dates and the number of roentgen exposures made during this interval, directly on the film jacket. The film is then returned to the central office, where it is developed in fresh solutions at 68° F. for five minutes and placed on file for future reference. A graduated series of dental films exposed to known amounts of radiation (0.1 r, 0.2 r, etc.) has been prepared in order that comparisons may be made and some idea obtained of the amount of radiation received. As a rough measure, it may be noted that a dental film exposed to 0.7 r is darkened sufficiently to render difficult the reading of news print. While the practice of carrying films has been in use only a short time, it has nevertheless assisted in discovering excessive exposure in a number of instances.

Search for Injury: As made clear previously (2), the full safety value of the present accepted standard of 0.1 r per day as a permissible exposure is not fully known. Hence, it has been desirable both as a protective measure and a research procedure to obtain routine blood counts. Each worker has therefore been asked to submit a routine blood report (red cells, white cells, hemoglobin, and differential cell count) each month, along with the exposed dental film. As yet blood changes constitute the most sensitive detectable response to radiation. The following criteria may be listed as evidence of blood injury: a lowered leukocyte level, either a high or low lymphocyte ratio, and a shift toward less mature granulocytes (*i.e.*, metamyelocytes, myelocytes, and blasts). The hazards of having blood counts made by various technicians are fully appreciated, but it is believed that some useful information may nevertheless be obtained.

Reports thus far have shown little aside from slightly lowered leukocyte levels. Somewhat more than the usual number of individuals showed leukocyte counts in the range of 4,000 to 6,000 cells per cubic millimeter of blood. In view of the fact that such persons appear normal in all other respects, the question is raised as to whether such changes constitute a health hazard. Paterson (6) states that very few healthy subjects present a series of white cell counts averaging less than 6,000, and that radiation workers who have an initial count above 6,000 are showing early signs of overexposure if the number of white cells through a series of counts averages below 5,000. He states further that in his opinion a leukocyte count of 4,000 or lower indicates definite and undesirable exposure injury requiring that some action be taken.

SUMMARY

The Tuberculosis Control Division of the U. S. Public Health Service has developed a program of personnel protection in photofluorographic units.

In the main this program consists of (1) provision of adequate protective equipment, (2) taking account of the human factor of indifference, (3) detection of stray radiation reaching each worker, and (4) watching for evidence of radiation injury in each worker.

The protective equipment consists mainly of lead screens so located as to shield workers from the radiation coming from the x-ray tube and the patient. The human factors are handled in part by locating foot and hand switches behind the screens in such a manner as to require the workers to be in proper location when exposures are made. Stray radiation is detected by means of dental films worn by

each worker for a specified period each month. Evidence of injury is sought through routine monthly blood counts.

ACKNOWLEDGMENTS: The authors wish to acknowledge indebtedness to Surgeon (R) C. M. Sharp for suggestions and critical review, Dean B. Cowie for suggestions concerning the measurements presented in the first paper, and Henry L. Meyer for valuable assistance in carrying out the measurements.

APPENDIX

An educational film strip (55 frames on 35-mm. period film) has been prepared on the subject "X-ray Protection in Photofluorography." A sound record accompanies the film strip and the presentation covers most of the material presented in this series of three papers. The sound strip method has been found to be an interesting and palatable means of disseminating facts and information to medical and technical personnel. The film, together with a suitable projector and sound amplifier, may be obtained on loan, without cost, from the Tuberculosis Control Division of the U. S. Public Health Service.

Tuberculosis Control Division
U. S. Public Health Service
Bethesda, Md.

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A Teratoid Tumor of the Chest: A Case Report[1]

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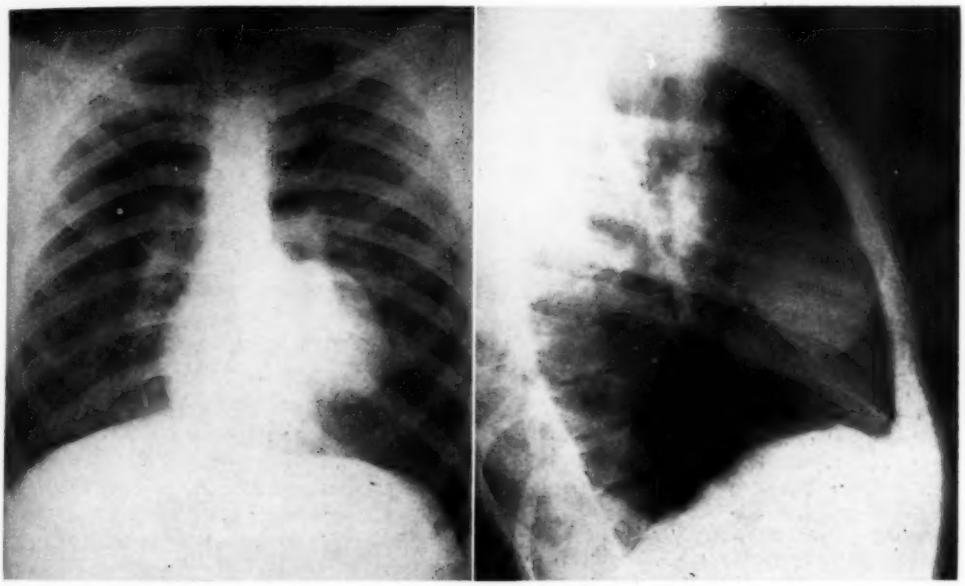
Accounts of mediastinal masses in the category of "embryonal rest tumors" are becoming more frequent in the literature; yet these cannot be classified as a common tumor. The use of roentgenography as a means of diagnosis has greatly increased the number of recognized cases. Harrington (1, 4) has reported a series of 16 cases, with correlation of the tumor tissue with the fundamental types. Other authors (3, 5) report isolated examples or smaller series.

These tumors are classified according to the fundamental type of tissue from which they arise, namely ectoderm, endoderm, and mesoderm. They are sometimes designated loosely as dermoids, since they often contain more than one type of embryonal tissue. It has been suggested that the term teratoid is more appropriate.

The following case is presented as representative of an anterior mediastinal tumor occurring as an incidental finding rather than to demonstrate the etiology of a clinical syndrome.

A 19-year-old white male who had been doing manual labor two days previously entered the hospital complaining of fever and redness and swelling of the legs. In the past he had been well except for a slight cough occasionally productive of a reddish sputum, mild intermittent pain underneath the sternum, and some dyspnea on exertion. He was a well developed boy with a slightly flushed face. The pupils were equal and reacted to light and accommodation. The tonsils were hypertrophied and red. There was a foul odor to the breath.



Figs. 1 and 2. Roentgenograms of the chest showing tumor and indicating its anterior position.

Examination of the chest showed the heart apparently enlarged, especially on the left side. The apex was beyond the mid-clavicular line. A murmur was heard obliterating the first sound and was thought to be both presystolic and systolic in time. It was not particularly harsh in character.

Both lung fields were clear and no râles or changes in breath sounds were noted. Examination of the

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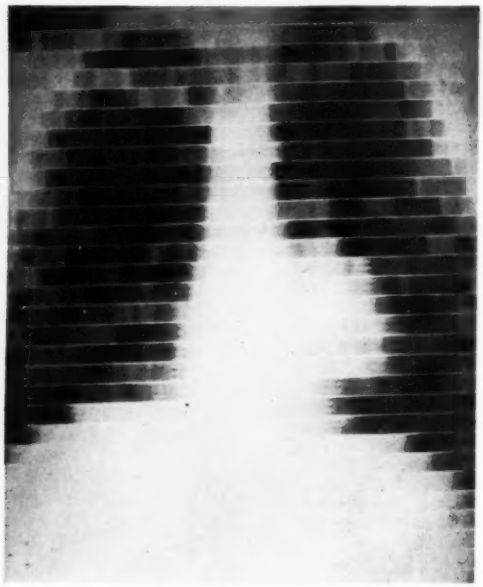

Fig. 3. Kymographic study showing transmitted pulsation.

abdomen was essentially negative. The liver and spleen were not palpable. There was a suggestion of edema of the lower extremities.

The blood pressure was 134/70; temperature, 101.6°; pulse, 105; respirations, 20. The blood showed 13.5 gm. hemoglobin; 12,300 leukocytes with 80 per cent neutrophils and 20 per cent lymphocytes. Blood chemistry: sugar, 105 mg. per cent; creatinine, 1.9 mg. per cent; N.P.N., 37.5 mg. per cent. The albumin was 4.5 gm. per 100 c.c. of blood; globulin, 2.24; fibrinogen, 0.45; total protein, 7,190 with an albumin-globulin ratio of 2.0. Blood cultures on several occasions were negative. The sedimentation rate was 10 mm. in sixty minutes. Urinalyses were essentially negative on several occasions. Subsequent blood studies were within the normal limits except for the sedimentation rate. Seven, ten, fourteen, and twenty-one days after entrance this was 21, 16, 14, and 10 mm., respectively.

Several electrocardiograms showed right axis deviation and the PR interval of one exceeded 0.20 sec.

Postero-anterior and left lateral roentgenograms of the chest showed a well circumscribed homogeneous mass in the anterior thoracic cage, overlying the left heart border. Kymographic study of this mass showed the pulsation along the left border of the heart to be transmitted rather than expansile.

Bronchograms made after the instillation of iodized oil showed that there was neither extrinsic nor intrinsic involvement of the bronchi.

The findings suggested the possibility of a tumor of the anterior mediastinum lying within the category of embryonal rest tumors. Hodgkin's or related lymphogranuloma could not be excluded nor could primary or secondary tumor of the pericardium or the myocardium (5).

Bronchoscopic examination revealed evidences of some extrinsic pressure on the lung structures about the region of the juncture of the upper and middle lobes, but no intrinsic lesion was noted. Pulsations about this area were suggestively increased.

An operation was performed after all examinations revealed a tumor which was probably resectable. The left fifth rib was resected, the thorax was entered through the rib bed, and the lung was deflated. An oval tumor about 5 × 9 cm. was found attached to the upper and lower lobes on the left in the interlobar space and to the pericardium adjoining. The mass was freed from the pleura and pericardium by blunt and sharp dissection. Cut section showed a very thin cyst wall; the center of the cyst was filled with an amorphous reddish-brown material. Microscopic examination revealed an unclassified cyst of mesodermal origin.

DISCUSSION

Clinically the differential diagnosis of teratoma is difficult, unless the tumor ruptures into a bronchus with expectoration of teratoid products, as hair, teeth, or sebaceous material. Several features, however, are often present. The patient is usually in the younger age group. Dyspnea, *per se*, is not of great diagnostic value, although combined with symptoms of pain it may be of aid. Pain was found in one series (1) to be the chief complaint and is more severe in malignant tumors. Hemoptysis as a symptom may be explained on two bases: it is probably more commonly due to erosion of an air passage by the tumor, but it has been suggested (2, 3) that venous congestion alone, due to tumor size, may result in hemoptysis. In our case, the latter is perhaps the best explanation. Laboratory procedures are of little help.

Correlation of symptoms reveals a patient in the younger age group, complaining intermittently of some retrosternal discomfort and dyspnea, with occasional attacks of hemoptysis, all of which can be tentatively ascribed to a tumor in the mediastinal area.

The roentgen diagnosis of embryonal rest tumors is difficult, if not at times impossible, because their morphological char-

acteristics are so variable. Most authors state that they are more commonly located in the anterior mediastinum than in the posterior and that an anterior mediastinal mass is more likely to produce symptoms than one in the posterior mediastinum.

The size of the mass may vary considerably. That in our case is but a "youngster" compared with those described by Harrington (1), Wheeler (7), Doran and Lester (6). The tumors vary from the size of a small walnut to a mass involving the entire thoracic cage on one side. Occasionally they may be bilateral, the extent of their growth limited only by the thoracic cage. Doran and Lester (6) reviewed the literature and found that they may exceed 7 to 8 kg.

The shape of the tumor also varies. The shadow cast upon the roentgenogram is smooth and well defined but may be obscured by densities caused by pathological reaction of the lung and surrounding structures. This gives an ill-defined shadow or the impression of lung tissue consolidation or even fluid. Wheeler (7) reports a case in which a cystic tumor of this type communicated with the pleural cavity to give the roentgenologic picture of pleural effusion.

Differences in the consistency of the tumors occur, but all have a tendency to cystic change. For this reason the shadow cast upon the roentgenogram may be mottled or homogeneous. Occasionally one might be fortunate enough to see a cyst with a fluid level. The well differentiated types may show teeth or bone, in which event the roentgenogram is diagnostic. However, the radiologist is usually not so fortunate, and the diagnosis will rest on exclusion of other types of tumor.

The differential diagnosis lies among the following conditions: lesions of the lymphogranuloma series and malignant tumors with a tendency toward local invasion; aneurysms; tumors of neurogenic origin; benign lesions of the adjacent or pulmonary structures, such as fibromas or lipomas. Harrington (1, 4) has repeatedly

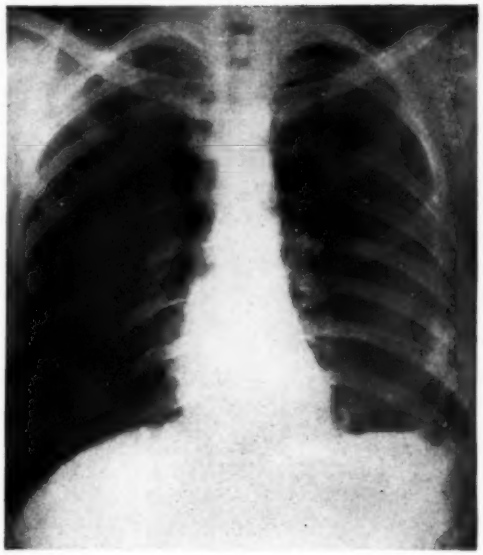

Fig. 4. Roentgenogram of chest after surgery.

emphasized the use of the roentgen ray as a therapeutic test to exclude lymphoblastoma and related diseases. It must also be said that with the increasing tendency to exploratory thoracotomy a valuable means of both early diagnosis and treatment is presented. Mortality rates in selected cases are sufficiently low to make the procedure encouraging.

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Neurofibroma of the Cauda Equina:[1] Report of a Case

MAJ. RAPHAEL POMERANZ, M.C., A.U.S.

PRIMARY NEOPLASTIC lesions arising from the spinal cord, nerve roots, and meninges comprise about 15 per cent of all central nervous system tumors. Among 35,000 autopsies in Vienna, Schlesinger (1898) recorded 994 tumors of the central nervous system, of which 151 were spinal cord neoplasms. Ewing (1931) collected 400 spinal cord tumors; out of that number 37, or 9 per cent, were neurofibromas. Peers (1936) found 4 intramedullary spinal cord tumors in 10,592 autopsies. Adson (1939) reported 557 intraspinal neoplasms; 163 of these, or 29 per cent, were neurofibromas. Of 275 spinal cord tumors removed surgically, Elsberg (1941) classified 59 as perineurial fibroma or neurofibroma. Of these, 54 were intradural neurofibromas; only 5 were extradural.

The case to be reported here represents a simple intradural circumscribed neurofibroma originating from the cauda equina, in a young soldier, recognized preoperatively and classified chiefly through the medium of myelography with Pantopaque.

Grossly, a neurofibroma is a circumscribed, encapsulated lesion, varying in size, arising from nerve-sheath cells. It may be single or multiple, benign or malignant, simple or plexiform, and may involve either the central or peripheral nervous system. Microscopically, elongated cells are demonstrable, showing a parallel arrangement of their nuclei, called palisading. Occasionally this tumor may show degenerative cystic change. If it arises from the perineurial connective tissue it is called a perineurial fibroblastoma. It may occur at any age, but single lesions are more common in the earlier age group. If it develops within the spinal canal, its symptoms depend on its location, size, and the amount of pressure it exerts on the spinal cord or nerve roots. It may be intradural or extradural, may be globular, bulbous, fusiform, or dumb-bell shaped. Neurofibromas of the cauda equina are less common than similar tumors in other parts of the spinal canal. They may occasionally reach large size, producing extensive bone destruction involving several vertebral segments.

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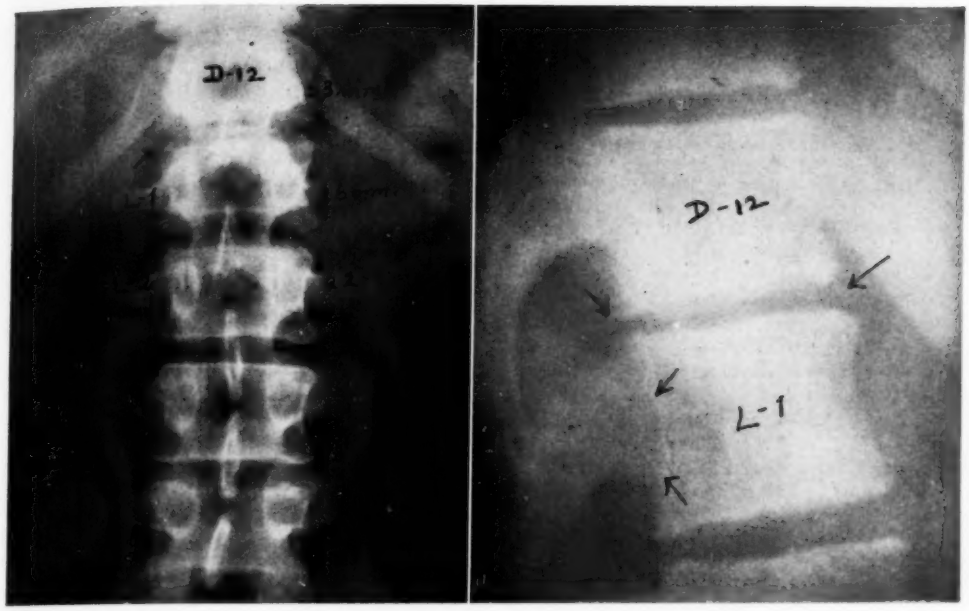
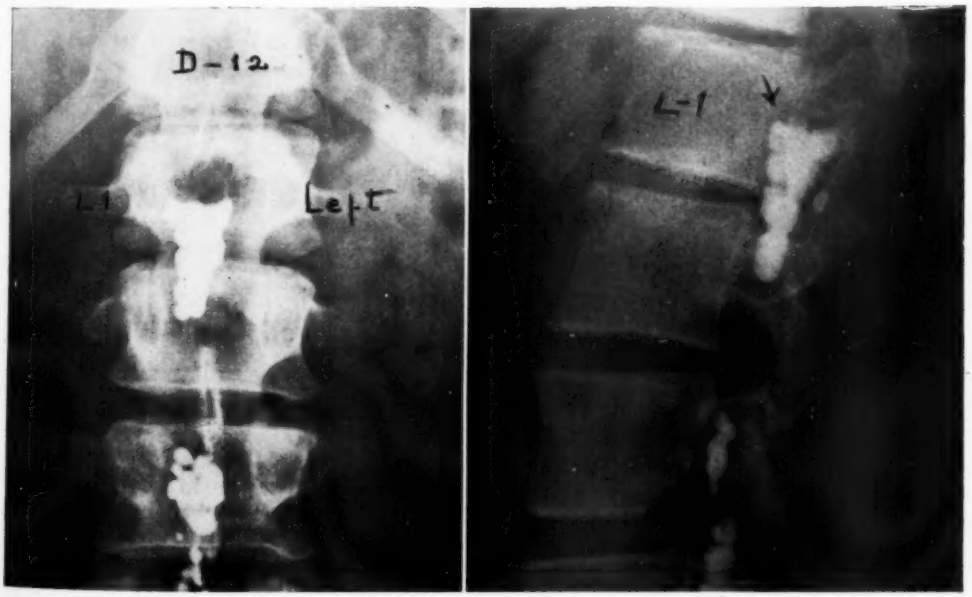
CASE REPORT

A 23-year-old soldier was inducted into the Army about two months prior to admission to the hospital. Five years earlier, after an effort of lifting, he experienced low-back pain. This had recurred on several occasions following similar effort. Two years before admission a severe attack followed a fall on the back, from a low truck. The attacks lasted two to three weeks, but in the long intervals between attacks the patient was relatively free of discomfort and able to carry on his routine duties on the farm. The attack was in the nature of a severe burning pain in the lumbosacral region, radiating to the right side of the scrotum, and the anteromedial aspect of the right thigh, with inconstant numbness and tingling sensations in the lateral aspect of the right thigh and muscle twitching in that region. The pain was aggravated by twisting and bending movements of the trunk, jarring of the body, and by coughing or sneezing. A few days after induction into the Army, on undertaking required calisthenics the patient experienced an especially severe seizure, completely incapacitating him. He was thereupon admitted to the Neurosurgical Service of Hoff General Hospital, in June 1944, and later transferred to Birmingham General Hospital.

Physical Findings (Capt. Edwin R. McKnight, M.C.): The patient, a rather small man, walked with a guarded gait, the head bent forward and the back rigid. His neck showed no deformity, but quick movements of the neck or compression of the internal jugular veins caused excruciating pain in the middle of the lumbar spine (Naffziger's sign). This pain was augmented by sudden release of jugular compression. The spine was rigid; it showed no gross deformity but marked limitation of motion due to muscular spasm. Percussion tenderness was noted over D-12 and L-1. There was general weakness of both lower extremities, with muscle atrophy of both thighs, more pronounced on the right side. Lasègue's sign was positive on both sides; Kernig's sign was negative, bilaterally. The reflexes of the lower extremities and the superficial



Figs. 1 and 2. Roentgenograms (July 12, 1944) of the dorsolumbar spine. The anteroposterior view (Fig. 1) shows the narrowed disk between D-12 and L-1; a small osteophyte at the caudal aspect of the body of D-12, on the right side; flattening out of the inner borders of the pedicles of L-1; and interpediculate measurement of L-1 of 26 mm. The enlarged lateral view of D-12 and L-1 (Fig. 2) shows the narrowed disk and the concave posterior border of the cortex of the body of L-1.



Figs. 3 and 4. Myelograms with patient in Trendelenburg position. Note the concave obstructive filling defect of the oil column in mid-portion of the body of L-1.

abdominal reflexes were normal on both sides. No pathological reflexes or sensory changes were observed throughout the body. The thorax showed a pigeon-breast deformity, evidently developmental. There was a varicocele on the left side, of moderate size.

Laboratory Findings: The spinal fluid, examined June 22, 1944, at Hoff General Hospital, was of xanthochromic appearance, with total protein of 700 mg. per cent. At Birmingham General Hospital, July 11, 1944, the spinal fluid examination revealed 19 leukocytes and 1 erythrocyte; globulin (Pandy test) 4-plus; total protein 4,500 mg. per cent. The Kahn test (July 11) was negative. Blood examination showed 4,000,000 red cells, 8,400 leukocytes, 14 gm. hemoglobin. The urine was negative for sugar and albumin.

Roentgen Findings (July 12, 1944): Plain anteroposterior and lateral films of the dorsolumbar region showed a mild kyphosis of the lower dorsal and lack of lordosis of the lumbar spine. The disk between D-12 and L-1 was narrowed (Fig. 1). One small osteophyte was observed at the right lateral border of the body of D-12. The pedicles of L-1 showed mild flattening out of their inner borders. The interpediculate measurement of D-12 was 23 mm.; of L-1, 26 mm.; of L-2, 22 mm. In the lateral view the posterior border of the body of L-1 showed a slight concavity (Fig. 2).

For *myelographic study*, 3 c.c. of Pantopaque were injected at the level of L-4. Fluoroscopic observations of the oil column showed free downward movement of the oil with the patient upright. In the Trendelenburg position, the oil stopped at the level of the mid-portion of the body of L-1. Following removal of the needle, anteroposterior and lateral views taken in the Trendelenburg position (Figs. 3 and 4) showed globulated filling of the right half of the spinal canal. The upper border of the oil column disclosed a concave defect consistent with an obstructive lesion.

Summary: The findings as described suggested an intradural obstructive, probably neoplastic, lesion in the spinal canal, on the right side, at the level of L-1, originating from the cauda equina. It was thought that this lesion was probably a small neurofibroma or similar structure.

Operative Report: The patient was operated on July 18, 1944, by Lt. Col. David L. Reeves, M.C. The initial incision was made on the right side of the mid-line, over what was thought to be the first lumbar vertebra, but which proved to be at a lower level. The incision was subsequently extended to the level of the spinous process of the 12th thoracic vertebra by means of sharp and blunt dissection and electric cautery. The dura was exposed and seemed to be non-pulsating. The spinous processes of this area were exposed and removed, along with their underlying laminae. This uncovered a bulging area of the dura, the site of the tumor. The dura was opened and a small fibroblastic tumor uncovered.

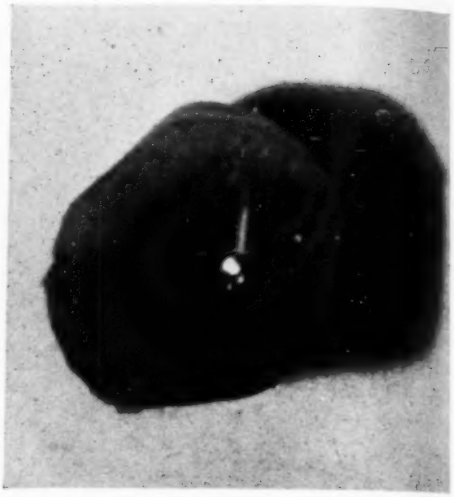


Fig. 5. Gross specimen. Cut section of the neurofibroma, enlarged one and one-half times.

The tumor was situated on the right side, with nerve roots entering and leaving it. The nerve roots of the cauda equina were sectioned, and the tumor was removed in its entirety. The sectioned nerve roots were approximated with interrupted sutures of fine black silk. The underlying muscles and skin were closed. A small amount of sulfanilamide crystals was sprinkled into the wound prior to closing. The patient tolerated the procedure satisfactorily and left the operating room in good condition.

Pathological Report (Capt. Onie O. Williams, M.C.): The gross specimen consisted of an encapsulated mass measuring 2.3 × 1.6 × 1.3 cm. in its greatest diameters (Fig. 5). The capsule was smooth and appeared to be intact except for one roughened area. On section, the capsule appeared thin. The cut surface was grayish-brown in color and its center showed a dark brown degenerated area suggestive of hemorrhage. Microscopically the tumor was composed of irregularly arranged strands of fibrous tissue having a moderate number of cells and abundant collagen (Fig. 6). Numerous blood vessels were present and interstitial hemorrhage was observed. The cells were uniform in size, of spindle shape, and showed palisading in several areas. No mitotic figures were found.

Diagnosis: Neurofibroma of the cauda equina.

Postoperative Course: The postoperative course was uneventful. The surgical wound healed in a few days and the patient was able to move about with ease. He was re-examined roentgenographically Aug. 14, 1944, at which time his clinical symptoms had completely disappeared. The x-ray study revealed smooth postoperative defects of the laminae of D-12, L-1, L-2, and L-3. A few residual globules of oil were seen in the spinal canal.

This case demonstrates the importance of myelographic localization of a small intraspinal lesion. Attention is called to the history of multiple traumas, representing a frequent etiological factor. The age of the patient and the clinical findings pointed to a spinal cord tumor, but its definite location and size were doubtful until the myelographic study was made. The complete obstruction of the oil column and its concave border indicated definitely a circumscribed lesion. Since the pressure erosion changes were mild and confined to one vertebral segment, and since the neurological symptoms were limited, it could be assumed that the lesion was small. Theoretically it would have been possible to visualize the upper border of the lesion by means of injection of another small amount of oil at a higher level, and by taking films in the erect position, outlining the lesion in its entirety. The level of the obstruction at L-1 suggested a lesion originating from the cauda equina. This was thought to be, most probably, a neurofibroma, since this tumor is not unusual in that area, being next in frequency to the meningiomas. There were no obvious x-ray signs of meningioma in this case. It is evident that the lesion was obstructive, but too small to produce extensive bone destruction or manifold clinical symptoms due to increased intraspinal pressure.

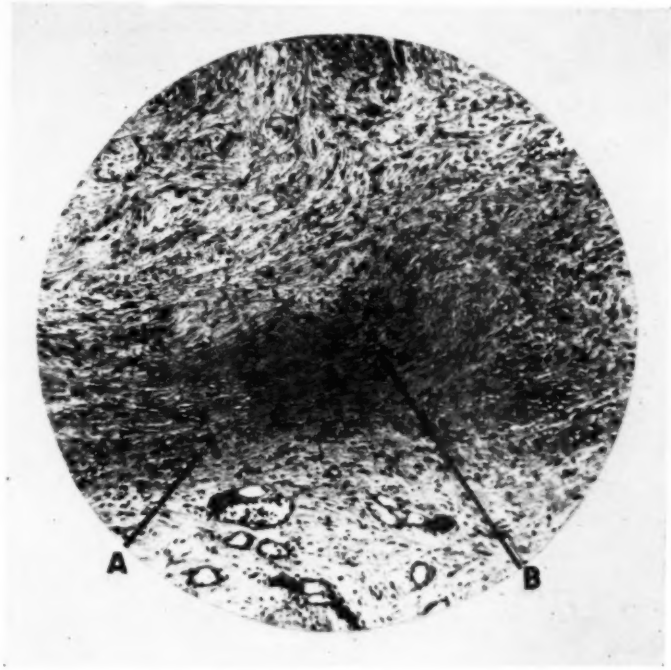


Fig. 6. Section of tumor showing strands of fibrous tissue (A) and cells with palisading (B).

SUMMARY

A case of neurofibroma of the cauda equina, in a young soldier, has been presented, with clinical, laboratory, myelographic, and microscopic findings. The patient was successfully operated upon and made a complete recovery. Proper correlation of the clinical history and symptoms with the myelographic findings is important in preoperative localization and determination of the size and probable character of these spinal cord tumors.

NOTE: I wish to express my appreciation to Lt. Col. David L. Reeves, M.C., Chief of the Neuro-

surgical Branch of the Birmingham General Hospital, and his Staff for their help and cooperation in preparation of this report.

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Close-Range Technic in Diagnostic Roentgenology

Supplementary Note

JULIAN ARENDT, M.D.

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AMONG THE inquiries received concerning "Close-Range Technic in Diagnostic Roentgenology," published in the February issue of RADIOLOGY, was one raising a question as to the safety of such exposures. In view of this, we had the output on our machine (Standard, 4-Valve, Rotating Anode Dynamax) at various voltages and at various distances checked by our physicist, Dr. Robert S. Landauer, who found the r-values to be as set forth in the accompanying table.

These values with the factors given—100 ma. seconds and 1 mm. aluminum filter—demonstrate that no danger is involved if certain rules are observed:

(1) The filter should be 1 mm. aluminum or its equivalent.

RADIOGRAPHIC EXPOSURE INTENSITIES
(Factors: 100 milliampere seconds; 1 mm. aluminum filter)

Kv. p.	Roentgens at 10 in.	12 in.	14 in.	16 in.	18 in.	20 in.
35	1.15	0.8	0.59	0.45	0.355	0.29
40	1.9	1.3	0.95	0.73	0.58	0.47
45	2.75	1.9	1.4	1.07	0.85	0.68
50	3.75	2.6	1.9	1.5	1.17	0.93
55	4.75	3.3	2.4	1.86	1.47	1.18
60	5.9	4.1	3.0	2.3	1.82	1.48
65	7.2	5.0	3.7	2.8	2.2	1.8
70	8.6	6.0	4.4	3.4	2.67	2.17
75	10.0	7.0	5.2	3.95	3.1	2.52

(2) A 10 to 15-inch cone should be used, attached to the tube.

(3) Close-range technic should not be frequently repeated but should be used selectively for the purpose of demonstrating detail.

EDITORIAL

Ulceration Associated with Diaphragmatic Hernia

The roentgen findings characteristic of herniation of a portion of the stomach through the esophageal hiatus and its counterpart resulting from congenital shortness of the esophagus have long been familiar. In many instances, however, these anatomical variations, unless of extreme grade, have been regarded as of little clinical importance. Only in recent years has it been generally recognized that gastric and esophageal ulceration is a frequent concomitant.

Para-esophageal hernia is encountered much more frequently during routine examinations of the digestive tract than is the congenitally short esophagus. The symptomatology is varied, depending upon the extent of herniation and the degree of constriction produced by the hernial opening. Hemorrhage is usually indicative of severe incarceration of the hernial sac with ulceration. The ulcers more commonly are superficial erosions, but in long-standing cases they may be deep and indurated, with heavy margins.

Ulceration is the result, in large measure, of constriction of the blood supply of the incarcerated sac and the attendant trauma produced by distention and retraction of the sac and by vomiting. Rude (5) reported two cases of ulceration associated with hernia. Such ulcers, he states, are more common beyond middle age. They occur for the most part on the lesser curvature of the stomach, a predisposing factor being stagnation of the stomach contents, which are thus afforded an opportunity to act on the gastric mucosa. Both of Rude's patients showed severe anemia, weakness, anorexia, and epigastric discomfort.

In a series of 30 cases of diaphragmatic hernia operated upon by Harrington (4), there were 8 with hemorrhage from the stomach. At operation, ulceration or erosion of the gastric mucosa was found in all of these. Harrington has never seen strangulation of the stomach as a result of hernia and does not believe it possible, because of the powerful musculature and rich blood supply of the gastric wall.

The congenitally short esophagus with a portion of the stomach above the diaphragm was first described in 1931 (3). Since that time many cases have been recorded and the essential findings have been well authenticated. These are the demonstration of a part of the cardiac end of the stomach in the thoracic cavity and an esophagus which fails to reach the level of the diaphragm. For the establishment of the diagnosis, this failure must be shown to be due to actual shortening, and for that reason tortuosity of the esophagus must be excluded. Some narrowing at the junction of the esophagus and the thoracic stomach is nearly always present. This area of narrowing has sometimes been mistaken for an esophageal stricture, but the widened barium shadow below and the history of lifelong dysphagia will usually eliminate this possibility. The most convincing evidence that the dilated lower portion of the barium shadow is truly gastric in origin is the presence of the characteristic multiple longitudinal rugal markings.

What has not been so generally understood is the frequent occurrence of chronic ulceration in the congenitally short esophagus. In 1934, Clerf and Manges (1) reported 14 cases of this anomaly, in 8 of which ulceration was observed, varying from a small lesion at the point of stenosis

to an extensive process involving the whole area of narrowing. On esophagoscopy, the ulceration appeared superficial, covered by a thin grayish exudate and sharply demarcated by a narrow inflammatory zone. In the more extensive cases, epigastric pain was associated with the ingestion of food.

More recently, Dick and Hurst (2) have re-emphasized the association of esophageal ulceration with the congenitally short esophagus and the accompanying diaphragmatic hernia. They believe that chronic esophageal ulcers are much more common than was formerly believed but that they rarely occur except in the presence of a diaphragmatic hernia. The ulcer is described as usually single and always involving the lower third of the esophagus immediately above the sphincter. The areas of scarring frequently observed with the esophagoscope suggest that the usual course of a chronic esophageal ulcer terminates in complete healing. Dick and Hurst are of the opinion that regurgitation of the acid gastric juice may be the potent cause of these ulcers, which they designate as peptic ulcers. On examination of the patient in the supine position, they observed that opaque material filled both the abdominal and the thoracic portions of the stomach, with regurgitation of the gastric contents into the esophagus. This is explained by loss of the valvular mechanism normally present at the cardia when it is situated in the abdomen.

Dick and Hurst found occult blood in the stools of all their patients: hematemesis occurred in three and melena in one. Hemorrhage is generally preceded by a long history of pain. Anemia is common and may be due to a single profuse hemorrhage or to repeated small ones. In some cases the anemia is in part nutritional, the result of a restricted diet.

On examination, the actual ulcer crater is frequently missed, and only the accompanying spasm is seen. The entire esophagus is best demonstrated with the patient in the right oblique prone posture. In this position the barium is held in the cardia and esophagus by gravity. Also, when the barium has been ingested, there will be an area of narrowing due to spasm near the lower end of the esophagus; below this is the ulcer niche, which is generally central but may be on either side. In many cases the diagnosis is made by esophagoscopy.

From the foregoing observations, it is apparent that ulceration may occur in conjunction with acquired para-esophageal diaphragmatic hernia and with the congenitally short esophagus, and that it is not as uncommon as was formerly believed. In the first type the ulceration is due to constrictive trauma; it occurs in the stomach at the site of herniation, and its demonstration may be relatively easy. In the second type the ulcer usually develops at the point of narrowing of the esophagus and may be secondary to the action of the gastric juice on the esophageal mucosa. The ulcer crater in these cases may be more difficult to demonstrate roentgenographically and the esophageal picture is often complicated by spastic phenomena.

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A Service for Radiotherapists

In an editorial appearing in the April issue of RADIOLOGY, Professor Mayneord of the Physics Department of the Royal Cancer Hospital (Free), London, called attention to the necessity of close collaboration between the radiologist and the physicist—a collaboration made the more imperative by the rapid advances in radiologic technic.

A concrete example of such collaboration has recently been brought to our attention, in the form of a service organized by the Hospital Physicists' Association of Great Britain, to facilitate the exchange of diagrams and other data (isodose curves, absorption coefficients, etc.) and of books, more especially those of foreign origin, between institutions concerned with radiotherapy.

The idea was inspired by the publication by Professor Mayneord in the *British Journal of Radiology* for December 1943 of a list of x-ray isodose curves, copies of which could be obtained, at the cost of reproduction, from the Royal Cancer Hospital (Free). At a subsequent meeting of the Hospital Physicists' Association, it was suggested that this idea might be extended, under the auspices of that Association, to include not only isodose curves but other diagrams and physical data which might be useful to radiotherapists. A committee, known as the Diagrams and Data Sub-Committee, was accordingly appointed to organize a scheme for the distribution of such material.

The scheme has now been in successful operation for about a year and a catalogue of items available has been prepared. These include reproductions of graphs and diagrams in a size suitable for practical use, tables of physical data, drawings of apparatus, and a limited list of books which have been made available by members of the Association for borrowing. It is further suggested that, if anyone wishes to obtain material not listed in the catalogue, he address the secretary of the subcommittee, who will endeavor to obtain the desired item. Prices for the service are moderate, and it is planned, as the scheme becomes established, to reduce them still lower.

A letter from Dr. John Read (Radiotherapy Department, London Hospital, Whitechapel, E. 1), Secretary of the Sub-Committee, points to the desirability of extension of the scheme so that it may be international in scope and voices the hope that it may be of use in the reconstruction of radiotherapy in the continental countries of Europe.

NEW HAMPSHIRE ROENTGEN RAY SOCIETY

The latest addition to the roster of state radiological societies is the newly organized New Hampshire Roentgen Ray Society. The officers are: Dr. Fred S. Eveleth of Concord, President, and Dr. Richard C. Batt of Berlin, Secretary-Treasurer.

COLONEL DE LORIMIER HONORED

For his services as Director of the Department of Roentgenology of the Army Medical School at Washington, from Sept. 8, 1939, to Oct. 1, 1942, Col. Alfred A. de Lorimier has been awarded the Legion of Merit. According to the citation, he "developed an easily transportable, complete and efficient field x-ray equipment for the Army which permits the location of bullets and shell fragments in the body of a wounded man and makes it possible for the surgeon to extract them. He tested all types of roentgenologic materials procured for the Army and formulated the specifications necessary for their purchase. He made extensive studies of the use of photoroentgenography and was instrumental in developing stereoroentgenography, which has a valuable use in induction centers and in mass surveys. By his initiative, original thinking, and development work he has performed outstanding service and contributed materially to the war effort."

RADIOLOGY records with pleasure the well deserved honor to a member of the Radiological Society of North America.

Letter to the Editor

We are happy to quote here from a letter recently addressed to the Editor by Lieut. Col. Elbert K. Lewis, M.C., A.U.S., Chief of the Roentgenological Services, 297th General Hospital:

"As one of the overseas radiologists having the opportunity to hear the seven excellent lectures on Bone and Joint Radiology (announcement in RADIOLOGY, February 1945) by Dr. James F. Brailsford of England, I wish to express my personal appreciation and gratitude to Dr. Brailsford through the pages of RADIOLOGY.

"I know I speak for many American radiologists to whom these first-rate lectures have been a source of learning and inspiration.

"In addition to these courses, Dr. Brailsford has been most generous with his time and energy in giving scientific presentations on radiological subjects to medical staffs at our hospitals in England.

"American medical officers have enjoyed the hospitality of Dr. and Mrs. Brailsford. At tea parties in their home and beautiful garden, we have had the exceptional opportunity of knowing, in an intimate atmosphere, the doctor and his charming wife.

"Acts of kindness, such as these, are deeply appreciated by us far away from home."

Book Reviews

RADIOLOGIC EXAMINATION OF THE SMALL INTESTINE. By ROSS GOLDEN, M.D., Professor of Radiology, College of Physicians and Surgeons, Columbia University; Director of the Radiological Service, The Presbyterian Hospital, New York. A volume of 239 pages, with illustrations of 183 subjects in 75 figures. Published by J. B. Lippincott Co., Philadelphia. Price $6.00.

Dr. Ross Golden's monograph, "Radiologic Examination of the Small Intestine," is one of the real contributions to the radiologic literature on a most difficult subject. In his usual way, the author has approached the subject in a thoroughly scientific manner, considering the embryology, the anatomy, and the physiology of the small intestine. He then enters into a description of the roentgen findings in the normal intestine in the infant and the adult. Following that, he considers the organic lesions, such as intestinal obstruction, the use of the Miller-Abbott tube in the diagnosis and treatment of ileus, disorders of nutrition, tumors, diseases of the mesentery, allergy, inflammations, congenital lesions, reflex disturbances, etc.

Dr. Golden has had a tremendous experience in the investigation of the small intestinal tract and he has made every effort to correlate unusual roentgenographic findings with operative and clinical observations, thereby presenting the medical profession with a book that is of real significance. As one reads, one again obtains the impression that the author feels that there is much more work to be done on the small intestinal tract. But to anyone interested in this subject, either from a physiological or a clinical standpoint or from the standpoint of future investigation, a broad basis of scientific consideration can be obtained from this book.

It is a great tribute to Radiology and to the young men who may take up that specialty in the future that they have been provided with such a fundamental book for study and reflection. It should be in the library of every radiologist and clinician interested in the intestinal tract.

The publishers are to be congratulated on the excellence of the paper, the printing, and the illustrations. It is gratifying that in this time of war, with its unavoidable limitations and restrictions, such an excellent piece of work is not spoiled by poor paper and poor workmanship.

RADIOLOGICAL SOCIETIES OF NORTH AMERICA

Editor's Note.—Will secretaries of societies please cooperate by sending information to Howard P. Doub, M.D., Editor, Henry Ford Hospital, Detroit 2, Mich.

UNITED STATES

Radiological Society of North America.—Secretary, D. S. Childs, M.D., 607 Medical Arts Building, Syracuse 2, N. Y.

American Roentgen Ray Society.—Secretary, Harold Dabney Kerr, M.D., Iowa City, Iowa.

American College of Radiology.—Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago 11, Ill.

Section on Radiology, American Medical Association.—Secretary, U. V. Portmann, M.D., Cleveland Clinic, Cleveland 6, Ohio.

ARKANSAS

Arkansas Radiological Society.—Secretary, J. S. Wilson, M.D., Monticello. Meets every three months and annually at meeting of State Medical Society.

CALIFORNIA

California Medical Association, Section on Radiology.—Secretary, Earl R. Miller, M.D., University of California Hospital, San Francisco, Calif.

Los Angeles County Medical Association, Radiological Section.—Secretary, Roy W. Johnson, M.D., 1407 South Hope St., Los Angeles. Meets second Wednesday of each month at County Society Building.

Pacific Roentgen Society.—Secretary, L. Henry Garland, M.D., 450 Sutter St., San Francisco. Meets annually during meeting of California Medical Association.

San Diego Roentgen Society.—Secretary, Henry L. Jaffe, M.D., Naval Hospital, Balboa Park, Calif. Meets first Wednesday of each month.

San Francisco Radiological Society.—Secretary, Carlton L. Ould, University Hospital, Medical Center, San Francisco 22. Meets monthly on the third Thursday at 7:45 P.M., first six months of the year in Lane Hall, Stanford University Hospital, and second six months in Toland Hall, University of California Hospital.

COLORADO

Denver Radiological Club.—Secretary, A. Page Jackson, Jr., M.D., 304 Republic Bldg., Denver 2. Meetings third Friday of each month at the Denver Athletic Club.

CONNECTICUT

Connecticut State Medical Society, Section on Radiology.—Secretary, Max Climan, M.D., 242 Trumbull St., Hartford 3. Meetings bimonthly, second Thursday.

FLORIDA

Florida Radiological Society.—Secretary-Treasurer, Charles M. Gray, 306 Citizens Bldg., Tampa 2.

GEORGIA

Georgia Radiological Society.—Secretary-Treasurer, James J. Clark, M.D., 478 Peachtree St., N. E., Atlanta 3. Meetings twice annually, in November and at the annual meeting of State Medical Association.

ILLINOIS

Chicago Roentgen Society.—Secretary, Fay H. Squire, M.D., 1753 W. Congress St., Chicago 12. Meets at the Palmer House, second Thursday of October, November, January, February, March, and April.

Illinois Radiological Society.—Secretary-Treasurer, William DeHollander, M.D., St. Johns' Hospital, Springfield. Meetings quarterly by announcement.

Illinois State Medical Society, Section on Radiology.—Secretary, Frank S. Hussey, M.D., 250 East Superior St., Chicago 11.

INDIANA

The Indiana Roentgen Society.—Secretary-Treasurer, Harold C. Ochsner, M.D., Methodist Hospital, Indianapolis 7. Annual meeting in May.

IOWA

The Iowa X-ray Club.—Secretary, Arthur W. Erskine, M.D., Suite 326 Higley Building, Iowa City. Holds luncheon and business meeting during annual session of Iowa State Medical Society.

KENTUCKY

Kentucky Radiological Society.—Secretary-Treasurer, Sydney E. Johnson, 101 W. Chestnut St., Louisville.

LOUISIANA

Louisiana Radiological Society.—Secretary-Treasurer, Johnson R. Anderson, M.D., North Louisiana Sanitarium, Shreveport. Meets annually at same time as State Medical Society.

Shreveport Radiological Club.—Secretary-Treasurer, R. W. Cooper, 940 Margaret Place. Meetings monthly on the second Wednesday, at offices of members.

MARYLAND

Baltimore City Medical Society, Radiological Section.—Secretary, Walter L. Kilby, M.D., 101 W. Read St., Baltimore 1. Meets third Tuesday of each month.

MICHIGAN

Detroit X-ray and Radium Society.—Secretary-Treasurer, E. R. Witwer, M.D., Harper Hospital, Detroit 1. Meetings first Thursday of each month from October to May, inclusive, at Wayne County Medical Society club rooms, 4421 Woodward Ave., Detroit.

Michigan Association of Roentgenologists.—Secretary-Treasurer, E. M. Shebesta, M.D., 1429 David Whitney Bldg., Detroit. Meetings quarterly by announcement.

MINNESOTA

Minnesota Radiological Society.—Secretary, A. T. Stenstrom, M.D., Minneapolis General Hospital, Minneapolis 26. Meetings quarterly.

MISSOURI

Radiological Society of Greater Kansas City.—Secretary, Arthur B. Smith, M.D., 306 E. 12th St., Kansas City, Mo. Meetings last Thursday of each month.

St. Louis Society of Radiologists.—Secretary, Edwin C. Ernst, M.D., 100 Beaumont Medical Bldg. Meets on fourth Wednesday of each month except June, July, August, and September, at a place designated by the president.

NEBRASKA

Nebraska Radiological Society.—Secretary-Treasurer, Donald H. Breit, M.D., University of Nebraska Hospital, Omaha 5. Meetings third Wednesday of each month at 6 P.M. in either Omaha or Lincoln.

NEW ENGLAND

New England Roentgen Ray Society (Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island).—*Secretary-Treasurer,* George Levene, M.D., Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday at Boston Medical Library.

NEW HAMPSHIRE

New Hampshire Roentgen Society.—Secretary-Treasurer, Richard C. Batt, M.D., St. Louis Hospital, Berlin.

NEW JERSEY

Radiological Society of New Jersey.—Secretary, H. R. Brindle, M.D., 501 Grand Ave., Asbury Park. Meetings at Atlantic City at time of State Medical Society and midwinter in Newark as called.

NEW YORK

Associated Radiologists of New York, Inc.—Secretary, William J. Francis, M.D., 210 Fifth Ave., New York City. Regular meetings the first Monday evening of the month in March, May, October, and December.

Brooklyn Roentgen Ray Society.—Secretary-Treasurer, Leo Harrington, M.D., 880 Ocean Ave., Brooklyn 26. Meets fourth Tuesday of every month, October to April.

Buffalo Radiological Society.—Secretary-Treasurer, Joseph S. Gianfranceschi, M.D., 610 Niagara St., Buffalo 1. Meetings second Monday evening each month. October to May, inclusive.

Central New York Roentgen Ray Society.—Secretary-Treasurer, Carlton F. Potter, M.D., 425 Waverly Ave., Syracuse 10. Meetings are held in January, May, and October, as called by Executive Committee.

Long Island Radiological Society.—Secretary, Marcus Wiener, M.D., 1430 48th St., Brooklyn 19. Meetings fourth Thursday evening each month at Kings County Medical Bldg.

New York Roentgen Society.—Secretary, Ramsay Spillman, M.D., 115 E. 61st St., New York 21, N. Y.

Rochester Roentgen-ray Society.—Secretary, Murray P. George, M.D., 260 Crittenden Blvd., Rochester 7.

NORTH CAROLINA

Radiological Society of North Carolina.—Secretary-Treasurer, Major I. Fleming, M.D., 404 Falls Road, Rocky Mount. Meeting with State meeting in May, and meeting in October.

NORTH DAKOTA

North Dakota Radiological Society.—Secretary, L. A. Nash, M.D., St. John's Hospital, Fargo. Meetings by announcement.

OHIO

Ohio Radiological Society.—Secretary, Henry Snow, M.D., 1061 Reibold Bldg., Dayton 2. Next meeting at annual meeting of the Ohio State Medical Association.

Cleveland Radiological Society.—Secretary-Treasurer, Don D. Brannan, M.D., 11311 Shaker Blvd., Cleveland 4. Meetings at 6:30 P.M. on fourth Monday of each month from October to April, inclusive.

Radiological Society of the Academy of Medicine (Cincinnati Roentgenologists).—*Secretary-Treasurer,* Samuel Brown, M.D., 707 Race St., Cincinnati 2. Meetings held third Tuesday of each month.

PENNSYLVANIA

Pennsylvania Radiological Society.—Secretary-Treasurer, L. E. Wurster, M.D., 416 Pine St., Williamsport 8. The Society meets annually.

The Philadelphia Roentgen Ray Society.—Secretary, Robert P. Barden, M.D., 3400 Spruce St., Philadelphia 4. Meetings held first Thursday of each month at 8:15 P.M., from October to May, in Thomson Hall, College of Physicians, 21 S. 22d St., Philadelphia.

The Pittsburgh Roentgen Society.—Secretary-Treasurer, Lester M. J. Freedman, M.D., 4800 Friendship Ave., Pittsburgh 24, Pa. Meets second Wednesday of each month at 6:30 P.M., October to May inclusive, at the Ruskin, 120 Ruskin Ave.

ROCKY MOUNTAIN STATES

Rocky Mountain Radiological Society (North Dakota, South Dakota, Nebraska, Kansas, Texas, Wyoming, Montana, Colorado, Idaho, Utah, New Mexico).—*Secretary,* A. M. Popma, M.D., 220 North First St., Boise, Idaho.

SOUTH CAROLINA

South Carolina X-ray Society.—Secretary-Treasurer, Robert B. Taft, M.D., 103 Rutledge Ave., Charleston 16.

TENNESSEE

Memphis Roentgen Club.—Chairmanship rotates monthly in alphabetical order. Meetings second Tuesday of each month at University Center.

Tennessee Radiological Society.—Secretary-Treasurer, J. Marsh Frère, M.D., 707 Walnut St., Chattanooga. Meeting annually with State Medical Society in April.

TEXAS

Dallas-Fort Worth Roentgen Study Club.—Secretary, X. R. Hyde, M.D., Medical Arts Bldg., Fort Worth, Texas. Meetings on third Monday of each month, in Dallas in the odd months and in Fort Worth in the even months.

Texas Radiological Society.—Secretary-Treasurer, Asa E. Seeds, Baylor Hospital, Dallas.

VIRGINIA

Virginia Radiological Society.—Secretary, E. Latané Flanagan, M.D., 215 Medical Arts Bldg., Richmond 19.

WASHINGTON

Washington State Radiological Society.—Secretary-Treasurer, Thomas Carlile, M.D., 1115 Terry Ave., Seattle. Meetings fourth Monday of each month, October through May, at College Club, Seattle.

WISCONSIN

Milwaukee Roentgen Ray Society.—Secretary-Treasurer, C. A. H. Fortier, M.D., 231 W. Wisconsin Ave., Milwaukee 3. Meets monthly on second Monday at the University Club.

Radiological Section of the Wisconsin State Medical Society.—Secretary, Russell F. Wilson, M.D., Beloit Municipal Hospital, Beloit. Two-day annual meeting in May and one day in connection with annual meeting of State Medical Society, in September.

University of Wisconsin Radiological Conference.—Secretary, E. A. Pohle, M.D., 1300 University Ave., Madison 6, Wis. Meets every Thursday from 4 to 5 P.M., Room 301, Service Memorial Institute.

CANADA

La Société Canadienne-Française d'Electrologie et de Radiologie Médicales.—General Secretary, Origène Dufresne, M.D., Institut du Radium, Montreal. Meetings are held the third Saturday of each month, generally at the Radium Institute, 4120 East Ontario Street, Montreal; sometimes, at homes of members.

CUBA

Sociedad de Radiología y Fisioterapia de Cuba.—Offices in Hospital Mercedes, Havana. Meetings are held monthly.

ABSTRACTS OF CURRENT LITERATURE

ROENTGEN DIAGNOSIS

The Head and Neck

The Chest

The Digestive System

The Skeletal System

Gynecology and Obstetrics

ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Some Roentgenological and Pathological Aspects of Calcification of the Choroid Plexus. Ernest H. Wood, Jr. Am. J. Roentgenol. **52:** 388–398, October 1944.

The literature on calcification of the choroid plexus is reviewed. Such calcification has been generally considered to be a regressive change and not of pathologic significance. It probably occurs for the most part through a process of proliferation of cells of the pia arachnoid followed by the formation of a dense collagenous and fibrous meshwork in which the calcium is deposited. The extent and location usually are quite symmetrical, but occasionally some degree of asymmetry does occur and calcification may be present only on one side.

Though found most commonly after the age of forty, choroid plexus calcification may occasionally be seen in children. The author reports two such cases in patients aged 2 1/2 and 3 years. In addition to calcification in the glomus (the usual site), there was calcification in the region of the interventricular foramina in each of these children.

Calcification in the choroid plexus of the fourth ventricle has not been described previously but the author reports a case in which such calcification was thought to be demonstrated in the form of a small punctate shadow in the region of this ventricle, remaining unchanged in appearance for six years.

Two cases are also reported to show the significance of displacement of a calcified choroid plexus for the diagnosis of an expanding intracranial lesion. One patient had a tumor in the left occipital region and the other an aneurysm of the basilar artery.

L. W. PAUL, M.D.

Adenoid Bronchosinusitis in Infants and Children. Stewart H. Clifford, Edward B. D. Neuhauser, and Charles F. Ferguson. M. Clin. North America **28:** 1091–1097, September 1944.

Adenoid bronchosinusitis in infants and children develops as a complication of upper respiratory infection. The infected adenoid tissue and nasal sinuses produce a purulent discharge that obstructs the nasal passage and descends into the trachea and bronchi. In time this postnasal dripping may penetrate the finer bronchi and set up a diffuse peribronchial infection.

The diagnosis of adenoid bronchosinusitis is made by x-ray demonstration of excessive adenoid tissue obstructing the postnasal space. Roentgen examination should include films of the maxillary, frontal, and ethmoid sinuses, and especially a satisfactory soft-tissue film of the nasopharynx, together with fluoroscopy and films of the chest. For the nasopharynx, in a two-year-old child, the technical factors are: distance 40 inches, 1/60 second, 200 ma., 65 kv. The exposure should be made at the moment when the nasopharynx is most apt to contain the maximum amount of air, so that soft-tissue contrast may be obtained. The patient should be breathing through the nose. In an infant the exposure should be made at the very beginning of the cry rather than on full inspiration or expiration. In an older child the best films are obtained while the patient is exhaling through the nose.

The interpretation of roentgen films of the sinuses rarely offers any difficulty except in the very young infant in whom, because of the small size of the ethmoid and maxillary sinuses, it is frequently difficult to recognize minor changes. The usual finding in adenoid bronchosinusitis is irregular thickening of the mucous membrane lining of the paranasal sinuses with or without retained secretions. Adenoid tissue is always excessive and produces a prominent soft-tissue shadow on the posterior nasopharyngeal wall. Frequently this collection of lymphoid tissue is so abundant that the nasopharyngeal airway is all but occluded. The chest films will in all cases show slight prominence of the hilar shadows and considerable accentuation of the bronchovascular markings. In older children the prominent markings are most evident at each lung base, while in the young infant, because of the habitual prone or supine position, the most prominent changes will be in the right upper lobe. Some perivascular congestion is often observed, and occasionally indefinite areas of peribronchial thickening or infiltration. Aeration of the lungs is usually somewhat irregular, with slight peripheral emphysema or localized bulging of one or more of the rib interspaces and occasional areas of lobular diminution in volume. These latter changes are more easily recognized and more frequently observed in the infant chest.

After a three-day course of sulfadiazine, the child's adenoids or tonsils and adenoids are removed. The results are immediate and gratifying.

Fissural Cysts. Harry C. Rosenberger. Arch. Otolaryng. **40:** 288–290, October 1944.

There are two types of fissural cysts developing at the sites of embryonal fusion of the various processes which unite to form the jaws, one resulting from fusion of the premaxilla and the maxilla, *i.e.*, a cyst of the facial cleft, and the other resulting from the fusion of the palatal process, *i.e.*, a cyst of the incisive canal. A case of each type is presented.

A 52-year-old Negro woman was first seen because of inability to breathe through her left nostril, the vestibule of which was occupied and distended by a globular tumor, producing an asymmetry of the face. The left nasofacial fold was obliterated, and the left upper lip was somewhat protruded. The tumor was soft and fluctuant, though not inflamed, and was limited to the vestibule and the anterior portion of the inferior meatus. The anterior tip of the inferior turbinate was thinned and displaced superiorly against the nasal septum. The superior alveolus was normal, but the globular fluctuant mass was palpable under the lip and just inferior to the piriform aperture. The mass could be moved readily by pressure over the nasal vestibule and counterpressure beneath the upper lip. It appeared to be about 4 cm. in diameter. Roentgen examination of the nose and bony structures adjacent to the left nasal vestibule revealed thinning of the medial bony wall of the left antrum. One of the views showed a sharply defined concavity in the lateral bony wall of the nasal cavity. These findings suggested absorption of bone under pressure. There was no evidence of any formation of a cyst in the alveolus. The cystic mass was removed through a sublabial approach. The diagnosis was nasoalveolar cyst.

A white man, aged 47, was seen because of a nasal fracture sustained two days previously and a painful swelling in the roof of the mouth of a week's duration, the two conditions being merely coincidental. Examination showed a fractured nose and a firm, tender, inflamed globular swelling about 2.5 cm. in diameter in the mid-line of the hard palate posterior to the alveolus, together with some swelling of the upper lip. It was planned to reduce the nasal fracture and incise the probable abscess of the hard palate. When the patient was seen in the operating room on the following morning, it was found that the abscess had ruptured spontaneously. To provide more adequate drainage, the swelling was incised and a small amount of bloody pus evacuated. At this time the swelling was thought to be caused by an infection of the bone of the hard palate. The floor of the swelling was carefully palpated with a probe to detect any bare rough bone, but none was found. A request for roentgen examination was misunderstood, and only the upper alveolus was reported on; this was normal except for an uninfected retained small tooth fragment. The nasal fracture having been reduced and the swelling of the hard palate having subsided, the patient was discharged. A review of the roentgenograms showed an oval area of decreased density in the mid-line of the hard palate anteriorly. Another roentgenogram taken about a month later also showed an oval smooth area of decreased density about 1 cm. broad and somewhat longer than wide in the anterior mid-portion of the hard palate. The roentgen diagnosis was benign cyst-like area in the superior maxilla. Since operation the patient has had two recurrences of a tender swelling in the anterior portion of the hard palate, but in each instance the swelling disappeared spontaneously, after discharging into the mouth. From the roentgen evidence and clinical course, it seems that the symptoms in this patient were due to a recurring infection of a cyst of the incisive canal. Roentgenograms from this case are reproduced.

THE CHEST

Bronchography in Pulmonary Tuberculosis: I. Normal or Questionable Roentgenographic Findings in Lungs and Positive Sputum. B. A. Dormer, J. Friedlander, and F. J. Wiles. Am. Rev. Tuberc. **50:** 283–286, October 1944.

Patients are encountered occasionally with sputum persistently positive for tuberculosis but with negative or equivocal chest roentgenograms. The authors report 5 such cases. In all of them iodized oil bronchography revealed sufficient abnormality in the bronchial tree to account for the positive sputum. In several, bronchiectasis involving the upper lobe bronchi was clearly demonstrated. In another case a dilated bronchus leading to a small apical cavity was seen. A complete bronchographic study is recommended for every patient with a positive sputum unaccounted for by adequate roentgen evidence. L. W. PAUL, M.D.

Bronchography in Pulmonary Tuberculosis: II. Radiographic Blackout-Evaluation of Underlying Lesions. B. A. Dormer, J. Friedlander, and F. J. Wiles. Am. Rev. Tuberc. **50:** 287–292, October 1944.

When a part or the whole of a lung is obscured because of the density produced by a thickened pleura or other pathologic process, evaluation of the underlying pulmonary disease can be accomplished by iodized oil bronchography. Seven cases are reported in which this procedure was employed to good advantage. The demonstration of atelectasis, bronchiectasis, and cavitation can be a relatively simple matter by this means, especially when body-section roentgenography is not available. L. W. PAUL, M.D.

Pathologic Anatomy of "Atypical Pneumonia, Etiology Undetermined." Acute Interstitial Pneumonitis. Alfred Golden. Arch. Path. **38:** 187–202, October 1944.

The anatomic lesions of acute interstitial pneumonitis were studied in 21 cases of death from "atypical pneumonia, etiology undetermined." All the cases showed an acute bronchiolitis. The bronchioles were dilated and their walls were infiltrated, chiefly with mononuclear cells, which extended into the peribronchiolar tissues, the alveolar walls, and the pulmonary septa. The chief lesions of the lungs were seen to be comparable to those of certain other infections, notably of influenzal pneumonia uncomplicated by secondary bacterial infection and uncomplicated measles pneumonia. There is anatomic evidence indicating but by no means proving that these lesions are caused by one or more viruses. It is further brought out that some persons dying of the disease succumbed to both acute interstitial pneumonitis and the effects of secondary bacterial infection, as lobular or lobar pneumonia.

A review of the literature shows the essential similarity of the lesions of the lungs in the acute interstitial pneumonia observed in this group of cases to those seen in animals and man in epidemic influenza and in measles. Other investigators who have studied isolated cases of death from this disease in the last ten years have reported pulmonary changes essentially like those described by the author.

Illustrative cases are presented which bring out the anatomic unity of this pulmonary lesion. The features of the lesion are not new, since similar lesions have been described in other diseases. This must not be taken to mean, however, that the disease itself or the etiologic agents have been seen clinically or epidemiologically in the past. Entirely different lines of investigation are required to solve that point.

Cardiospasm as a Cause of Pneumonitis. Wm. Gray and I. R. Jankelson. New England J. Med. **231:** 522–525, Oct. 12, 1944.

In view of the extreme dilatation of the esophagus that may result from cardiospasm, it is not too much to expect that the retained material may spill over into the larynx and lower respiratory tract, causing a pneumonitis. Two new cases are added to those previously reported in the literature.

Radiographically the dilated esophagus may be suspected from an apparent enlargement of the right cardiac border, or possibly a fluid level may be seen in the mediastinum. Examination with barium will establish the diagnosis. JOHN B. MCANENY, M.D.

Broncholithiasis. William S. Tinney and Herman J. Moersch. S. Clin. North America **24:** 830–838, August 1944.

The origin of broncholiths may be endobronchial or extrabronchial. In most instances they arise from

calcified tuberculous peribronchial lymph nodes that gain entrance to the lumen of the bronchus by erosion and ulceration.

Twenty-eight cases of broncholithiasis have been recorded at the Mayo Clinic. The symptoms depend on the size and shape of the calculus, the degree and duration of the bronchial obstruction, and the secondary changes which may take place distal to it in the pulmonary tissue. Cough was a prominent symptom in each of the 28 cases; in 50 per cent it was severe and paroxysmal. An associated asthmatoid wheeze—so-called "stone asthma"—may be observed. Thoracic pain was an important feature in 13 cases. Hemoptysis usually occurs during or immediately after expectoration of the calculus and was present in 18 cases in this series. Fourteen patients had recurring attacks of chills and fever that were usually diagnosed as influenza or pneumonia.

Whenever there is evidence of an obstructing lesion of the bronchus, a broncholith should be suspected, as well as an aspirated foreign body and bronchiogenic carcinoma. Occasionally, the patient's history and the demonstration of calcification in the roentgenogram of the thorax may lead to a tentative diagnosis of broncholithiasis. Confirmation depends on visualization of the stone in the sputum or at bronchoscopic examination.

In general, the prognosis in cases of broncholithiasis is excellent, particularly if the concretion is expelled spontaneously or removed bronchoscopically soon after the onset of pulmonary symptoms. If the broncholith is not removed or expelled, dangerous sequelae in the form of bronchiectasis or pulmonary abscess are likely to occur. In 10 cases of this series, pulmonary suppuration was secondary to the prolonged bronchial obstruction. In one of this group a fatal metastatic abscess developed in the brain nine months after the onset of pulmonary symptoms.

Pulmonary Abscess. Arthur M. Olsen and O. Theron Clagett. S. Clin. North America **24:** 851–862, August 1944.

Pulmonary abscesses are classified by the authors as simple and complicated, as suggested by Overholt and Rumel (New England J. Med. **224:** 441, March 13, 1941. Abst. in Radiology **37:** 515, 1941). A simple abscess may be defined as a solitary cavity in the lung without associated bronchiectasis or pulmonary fibrosis. Such an abscess is usually an early one, observed but a few weeks after its origin. The complicated pulmonary abscess may be multilocular and is characterized by an associated bronchiectasis, pulmonary fibrosis, or empyema. Complications may develop at any stage in the course of pulmonary abscess. Their recognition is important in evaluating the prognosis and in determining the treatment of choice. Adequate roentgenographic studies and bronchograms may be of great assistance.

Aspiration of infected oronasal secretions is the most important factor in the production of pulmonary abscesses. Other basic factors are bronchial obstruction by foreign bodies, bronchial tumors, external bronchial compression, or the so-called mucous plug; disturbance of the physiologic mechanisms of the bronchi and bronchioles; local ischemia of the pulmonary segment.

The early diagnosis of pulmonary abscess is sometimes difficult. Postoperative fever, cough, and dyspnea should suggest a pulmonary complication, and if the lesion fails to resolve after the usual measures have been taken, an abscess should be suspected. Similarly, pulmonary suppuration should be considered when pneumonia fails to resolve in the customary fashion.

Roentgenographic studies are of the greatest importance in all phases of pulmonary abscess, though in the early stages the roentgen changes alone are not diagnostic, as the pulmonary infiltrates resemble pneumonia, pneumonitis, atelectasis, or infarction. When bronchial communication has occurred, however, a partially filled cavity may be discerned if the films are taken with the patient in the upright position. Adequate roentgenograms are of the greatest importance in localizing the abscess in relation to the thoracic wall when external surgical drainage is contemplated. Stereoscopic films, anteroposterior, lateral and oblique views made with the Bucky diaphragm, and roentgenograms taken in lateral decubitus are all of assistance in localizing the lesion. Roentgenograms should be made at regular intervals until healing is complete. Bronchography made with iodized oil is necessary to detect associated bronchiectasis, before and after treatment. Bronchoscopic examination is desirable in all cases of pulmonary abscess for diagnostic and frequently for therapeutic reasons.

The object of treatment of pulmonary abscess is to provide adequate drainage before complications have developed. Endobronchial drainage will occur spontaneously in 20 to 25 per cent of all cases. When bronchoscopic aspiration is combined with postural drainage and other medical measures, more than half of all pulmonary abscesses may be managed satisfactorily without surgical intervention. External drainage by surgical means should be employed in all cases of uncomplicated pulmonary abscess in which the response to medical management and bronchoscopic therapy is not prompt and adequate. Complicated abscesses do not respond well to either medical or surgical treatment; in selected cases lobectomy or pneumonectomy is indicated.

Round Densities Within Cavities. Lung Lesions Simulating the Pathognomonic Roentgen Sign of Echinococcus Cyst. I. D. Bobrowitz. Am. Rev. Tuberc. **50:** 305–312, October 1944.

Two cases are reported in which roentgenograms revealed an area of homogeneous density within a bronchiectatic cavity in the lung. Lobectomy was done in both. In one the x-ray changes were found to be due to a mass of inspissated pus within a cavity; in the other the density was due to a blood clot. Formerly the appearance of a round mass surrounded by a crescentic air space was considered to be pathognomonic of an echinococcus cyst of the lung. These cases show that other lesions may be responsible for this type of roentgenologic shadow. L. W. PAUL, M.D.

Tracheocele. E. Addington, P. Rusk, and W. Cohen. Am. J. Roentgenol. **52:** 412–414, October 1944.

Diverticula of the trachea are infrequent and rarely diagnosed clinically. A case is reported in which such a lesion was discovered by roentgen examination in a patient whose chief complaints were episodes of coughing, wheezing, and choking. Bronchography

demonstrated bilateral lower lobe bronchiectasis and a diverticulum in the upper third of the trachea, measuring 5 × 4 × 5 cm. The lumen of the trachea below the diverticulum was somewhat increased in size. In this case the lesion was considered to be due primarily to a congenital defect in the posterior tracheal musculature with the formation of a diverticulum by increased bronchial pressure produced by coughing.

L. W. PAUL, M.D.

Arteriovenous Fistula of the Lung: Report of a Patient Cured by Pneumonectomy. John C. Jones and William P. Thompson. J. Thoracic Surg. **13:** 357–371, October 1944.

The authors present a detailed report of a case of arteriovenous fistula of the right lung cured by pneumonectomy. This is believed to be only the sixth example of this condition to be reported and the third in which operation was successful.

The patient was a woman of 24, cyanotic from birth and with clubbing of the fingers progressive between the ages of nine and sixteen and stationary thereafter. A year and a half before she was seen by the authors, an intrathoracic mass was discovered by roentgenography, and radiation therapy was given without effect.

Examination revealed a polycythemia, presumably secondary, and a loud rough murmur over the intrathoracic mass. The latter was demonstrable in roentgenograms (including planigrams) as a multilobulated tumor at the base of the right lung, resting on the diaphragm. Superiorly the mass was continuous with large vessels coming from the upper part of the right hilus, believed to be dilated branches of the right pulmonary artery. The tumor appeared to pulsate. The heart was normal. A diagnosis of arteriovenous aneurysm of the lung was made. A pneumothorax was instituted in an attempt to collapse the dilated vessels but proved of no value. At operation, local removal of the aneurysmal mass did not seem feasible and a pneumonectomy was done with excellent results.

On the basis of the cases observed up to the present time, the authors state that arteriovenous fistula of the lung produces a syndrome characterized by cyanosis, clubbing of fingers and toes, symptomatic polycythemia, and symptoms of anoxemia, usually in a young patient with an obscure lung tumor and a normal heart. A continuous murmur may be heard over the tumor.

HAROLD O. PETERSON, M.D.

Intrathoracic Hodgkin's Disease. Sidney E. Wolpaw, Charles S. Higley, and Harry Hauser. Am. J. Roentgenol. **52:** 374–387, October 1944.

A series of histologically proved cases of Hodgkin's disease was studied from the standpoint of intrathoracic involvement and with particular reference to those types of involvement that might be confused with other pulmonary or mediastinal disease. Thirty-five in this series of 55 proved cases showed intrathoracic lesions. These are divided into five groups:

I. *Mediastinal Type.* Mediastinal involvement was the most common, 50 per cent of the cases falling into this category. The roentgen manifestations, which are those of lymph node enlargement, vary with the site and extent of the disease. They are not pathognomonic and may be mimicked by other conditions, so that final diagnosis depends upon biopsy of peripheral nodes or other accessible material.

II. *Parenchymal Type.* Involvement of the lung parenchyma occurred in 40 per cent of the cases and the roentgen changes varied widely. In some the pulmonary infiltrates resulted from direct extension from the mediastinal nodes, occurring as a solid growth into the lung, producing the picture of a massive tumor. In others infiltration extended along the peribronchial and perivascular lymphatics, producing linear or feathery infiltrations on the roentgenogram. Granulomatous consolidation resembling pneumonia was occasionally seen. A less frequent manifestation was the development of circumscribed nodules closely simulating the appearance of pulmonary metastases. Other parenchymal changes occasionally observed were atelectasis and cavitation.

III. *Pleural Type.* Pleural involvement was frequent, occurring as nodular or infiltrating masses on the pleural surface. These lesions may produce massive and persistent effusions, usually serous in nature.

IV. *Osseous Type.* The bones of the thorax may be involved by direct extension of the disease from the mediastinum, lungs, or pleura, and occasionally primary osseous lesions are seen.

V. *Cardiac Type.* The heart is rarely affected except by direct extension from adjacent structures. If it is involved, objective evidence consists of changes in rhythm, size and shape, and evidences of myocardial insufficiency.

Twenty-three of the 35 cases were treated by roentgen irradiation, 17 showing a favorable response after adequate treatment.

Fifteen case histories illustrating the various types of involvement are included, with numerous illustrations.

L. W. PAUL, M.D.

Intrathoracic Mediastinal Lipoma. Thomas B. Wiper and Joseph M. Miller. Am. J. Surg. **66:** 90–96, October 1944.

A case of a completely intrathoracic mediastinal lipoma in a 46-year-old white soldier is reported. The patient was admitted to the hospital complaining of dyspnea and palpitation on exertion. He had gained 35 pounds in weight in the previous two years. Examination of the chest revealed flatness of the left base with absent fremitus and decreased breath sounds which angled off into the left axilla, suggesting a pleural or pericardial effusion.

A roentgenogram of the chest revealed a large soft-tissue mass occupying the lower half of the left lung field and displacing the heart and mediastinum to the right. Fluoroscopy showed a heart of normal size and slight displacement of the esophagus toward the right. A small amount of either obstructive or compressive atelectasis of the lower portion of the left lung was thought to be present. Gastro-intestinal studies were negative. No fluid was obtained on attempted aspiration of the left pleural cavity. A postero-anterior chest film, with the patient in an exaggerated Trendelenburg position, showed the mass in the left mediastinum to "flow cephalad;" films with the patient in the upright position showed the mass to "flow caudally." Roentgen studies after the introduction of 300 c.c. of air into the left pleural space failed to reveal shifting fluid levels. An anteroposterior view with the patient on his right side clearly outlined the costophrenic sinus on the left with a small cushion of air, showing in the contrast film adjacent lung tissue with

the superposition of the smoothly curved border of the mass, both the lung and the mass itself having been separated from the parietal pleura by the intervening air, demonstrating the extrapleural and extrapulmonary situation of the tumor.

The roentgen studies described above, lipiodol filling of the left bronchial tree, bronchoscopy, and other diagnostic procedures revealed but one definite finding —an extrapulmonary mass, extrapleural and quite large in size, impinging upon the bronchus of the left lower lobe, compressing the lower portion of the left wall of the trachea, and producing a moderate degree of atelectasis of the lower left lung. The size of the tumor and the evident good health of the patient militated against a diagnosis of a malignant growth. The anterior position in the chest tended to rule out the commoner types of tumor in the posterior mediastinum. Operation revealed a completely intrathoracic mediastinal lipoma. This was extirpated and, after some postoperative complications, the patient made an excellent recovery.

Parasternal Diaphragmatic Hernia. Max Ritvo and O. S. Peterson, Jr. Am. J. Roentgenol. **52:** 399–405, October 1944.

Parasternal diaphragmatic hernia may result from a failure of fusion of the sternal and costal portions of the diaphragm, the so-called foramen of Morgagni. Even under normal conditions, Larrey's spaces, which correspond anatomically with the foramen of Morgagni, form congenitally weak areas in the diaphragm which may predispose to herniation since deficiencies in the diaphragmatic musculature are normally present in these areas. The incidence of parasternal hernias is low and they are among the least frequently diagnosed hernias. Morton, in 1939 (Surg., Gynec. & Obst. **68:** 257, 1939), was able to find only 120 reported cases.

Roentgen study of the chest reveals a sharply rounded shadow in the anterior lower lung field adjacent to the right heart border. Such a shadow requires that parasternal hernia be considered the diagnosis until proved otherwise. The density may be uniform if the hernia contains only omentum or fluid-filled gut. If the colon lies within the sac, gas-filled haustrations may be visible. Barium meal and enema studies are of utmost importance in diagnosis. If omentum only is present in the hernia, there are varying degrees of upward and medialward displacement of the right side of the colon. When a loop of the colon is in the hernia, barium filling will lead to the correct diagnosis.

Roentgenograms are reproduced illustrating two cases, details of which are given in the legends.

L. W. PAUL, M.D.

THE DIGESTIVE SYSTEM

Roentgenographic Appearance of the Esophagus in Normal Infants. Harry Bakwin, Eleanor Galenson, and Bernard E. LeVine. Am. J. Dis. Child. **68:** 243–247, October 1944.

The esophagus was studied with the aid of a barium-acacia mixture in 32 infants ranging in age from three weeks to twenty-two months. In all but 4 patients examination was made in the supine position.

Fluoroscopically, the mixture descended the esophagus rapidly in a narrow column, immediately entering the stomach. As the feeding continued, the cardiac orifice would open and close intermittently. Stasis was then noted, most often in the distal third of the esophagus, with occasional pooling in the proximal as well as the distal third and at times persistent filling of the entire organ. Accumulation of barium produced temporary distention of the esophagus, and several instances of tortuosity were seen. Regurgitation of barium and gas bubbles occurred for a considerable time following the feeding and ranged from partial or complete filling of the esophagus to expectoration.

The roentgen illustrations adequately demonstrate the smooth-walled contours of the esophagus and the various phases of filling described.

LESTER M. J. FREEDMAN, M.D.

Gastric Carcinoma: Observations on Peptic Ulceration and Healing. Walter Lincoln Palmer and Eleanor M. Humphreys. Gastroenterology **3:** 257–272, October 1944.

Ulceration with clinical and pathologic evidence of healing is seen not infrequently in epithelial neoplasms. The process is of particular interest in the stomach because of two problems: first, the difficulty of clinical, roentgenologic, gastroscopic, and even pathologic differentiation between a benign and malignant ulcer; and second, the possibility of neoplastic changes in benign ulcer. Nowhere else in the body is the situation exactly the same because, with few exceptions, tumor tissue is exposed to peptic ulceration only in the stomach.

Four cases are presented, which emphasize the role of peptic digestion in ulceration in pre-existent carcinoma and afford additional evidence of the degree of healing, clinical and pathologic, to be found in such lesions under certain conditions. In none of these cases was there definite clinical evidence of pre-existing benign ulcer. In all of them the duration and the history were compatible with a primary ulcerating neoplasm; gastroscopic evidence of neoplastic infiltration was found in all at the first examination. Pathologically two of the lesions presented in many respects the classical characteristics of a benign ulcer, such as complete destruction of an area of muscle corresponding in size roughly to the floor of the ulcer and the presence of a large area of dense fibrous and granulation tissue covered by a necrotic layer. Roentgenograms for 3 cases are reproduced, showing a remarkable decrease in the size of the crater with the healing process, with subsequent increase and recurrence of symptoms.

The authors conclude that certain ulcerating gastric carcinomas may present the architecture characteristic of peptic ulcer. This typical structure is attributed to peptic digestion of the carcinoma and adjacent tissue. In such ulcers there may be marked or even complete repair of the tissue defect. The scar of the ulcer may be covered by neoplastic mucosa or by a layer of epithelium perfectly normal in appearance.

Varied Clinical Manifestations of Lymphosarcoma of the Stomach. Henry A. Rafsky, Harry Katz, and Charles I. Krieger. Gastroenterology **3:** 297–305, October 1944.

Eleven cases of proved lymphosarcoma of the stomach and one probable case are presented. All of the patients came to operation. Their ages ranged from 19 to 80 years. Seven were males.

There was no characteristic history indicating the

presence of the growth. Six patients had symptoms simulating peptic ulcer and even showed temporary improvement on an ulcer regime, but continued to lose weight. Physical examination in most of the patients was not diagnostic. In 4 cases, an abdominal tumor was palpable. Roentgenography resulted in a definite diagnosis of lymphosarcoma in 4 patients and of possible neoplasm in 6 patients. In 2 cases, not examined by the authors, a roentgen diagnosis of gastric ulcer was made.

Interstitial Ventral Hernia Involving the Small Intestine. Case Report. William Gray and Moris Horwitz. Am. J. Surg. **66:** 134–135, October 1944.

Although over 500 cases of interstitial hernia of the inguinal region have been reported, a review of the American literature failed to reveal any cases of ventral hernia of the interstitial type. Such a case in a 64-year-old colored woman is presented. The patient complained of attacks of dull, gripping abdominal pain starting on the right side and spreading over the entire abdomen, with associated nausea. Twenty-two years previously an abdominal laparotomy had been performed and a ruptured peptic ulcer successfully repaired. The patient now noticed that a "hard lump" developed near the old right rectus scar in association with the attacks. Ordinarily, these attacks occurred about once or twice a month and lasted from two to three days.

Examination of the abdomen showed a sausage-shaped, soft mass on the right side, extending from the right iliac crest to the right costal arch. The mass was fixed and moderately tender. A palpable defect in the lower part of the right rectus scar suggested the possibility of a ventral hernia.

X-ray examinations of the gallbladder and kidneys were normal. Barium meal studies of the upper gastro-intestinal tract showed no pathological condition involving the stomach or duodenum, but it was noted that a few loops of the small bowel apparently lay on the outside of the abdominal wall. Small-intestinal studies, with films taken three hours following a barium meal, resulted in the diagnosis of interstitial hernia involving the small bowel, for loops of barium-filled small bowel were clearly seen to lie between an apparent split in the muscle sheaths of the right lateral abdominal wall. No obstruction was noted. A barium enema revealed no intrinsic abnormalities involving the colon. Operation confirmed the roentgen diagnosis.

Diagnosis of Fibrocystic Disease of the Pancreas. Based upon Twenty-Six Proved Cases. H. F. Philipsborn, Jr., G. Lawrence, and K. C. Lewis. J. Pediat. **25:** 284–298, October 1944.

Fibrocystic disease is the clinical manifestation of extensive pancreatic cystic fibrosis. The findings in 26 cases studied at necropsy are presented.

Unlike celiac disease, which first becomes apparent during childhood, fibrocystic disease has its inception in infancy. Ordinarily it manifests itself in one of three forms: (*a*) primarily in respiratory difficulty; (*b*) primarily in gastro-intestinal disturbances; (*c*) in a combination of respiratory and intestinal difficulties. The patient is usually under one year of age and often emaciated. The extremities are spindle-like; the abdomen protuberant. The chest is frequently hyperresonant and the area of cardiac dullness diminished. Auscultation may reveal reduced alveolar air exchanges, with showers of fine moist and sticky râles throughout the chest. Roentgenography has been valuable in diagnosing pulmonary involvement. In far advanced cases with physical findings of emphysema and atelectasis, roentgenograms have often revealed a mottled shadow about the heart accompanied by less dense mottling throughout both lung fields. This picture is considered compatible with multiple lung abscesses, probably of *Staphylococcus aureus* origin.

There is a considerable reduction of pancreatic enzymes in the intestinal lumen. Stools are not necessarily "characteristic" but vary in different individuals and even in the same individual; at one time they may be foul, greasy, and loose; at another time, scybalous, brown, and odorless. The vitamin A curves in patients with fibrocystic disease have been flattened and at all times under 30 units. This, like the hypocholesterolemia, may be only a reflection of poor fat absorption. An elevation in the vitamin A absorption is in direct proportion to the increased intestinal motility.

Treatment of children with fibrocystic disease should be directed toward the pulmonary and gastro-intestinal complications. Bronchoscopic aspirations, postural drainage, vaccines, the sulfonamides, and penicillin are without benefit once pulmonary abscesses have developed. The gastro-intestinal disturbances have been managed by diets high in protein and low in fats. Pancreatic extracts have been administered orally before feedings. Parenteral vitamin A has been given in doses as large as 50,000 units triweekly. This regime in a few instances has produced a favorable response.

THE SKELETAL SYSTEM

Acute Manifestations of Yaws of Bone and Joint. Arthur J. Helfet. J. Bone & Joint Surg. **26:** 672–681, October 1944.

Yaws is the most common disease of bones and joints in the tropics. While its manifestations are similar to those of syphilis, the author, after eighteen months of observation in West Africa, believes that certain features occur, if not solely, at least more constantly in yaws, thus permitting its differentiation.

Syphilis tends to attack bones and joints slowly and silently. A syphilitic gumma of a joint surface may not cause even muscle spasm or limitation of motion, but in yaws a juxta-articular lesion may simulate arthritis, with joint pain, tenderness, swelling, muscle spasm, and limitation of motion. In the long bones the disease may resemble a septic osteomyelitis, with pain, tenderness, swelling, and fever of a mild degree. The onset may follow trauma and be accompanied by fever with widespread rheumatic pains.

The tibia, lower end of the femur, inner end of the clavicle, and the lower end of the humerus are the sites of election, but other bones may also be attacked. Palmar and plantar skin lesions are rarely present when bone is involved, and the bone lesion seldom ulcerates through the skin.

The radiographic picture resembles syphilis, showing an increase in the diameter of the bone, greatly increased density, and one or several "punched-out" areas. The acute lesion often shows subperiosteal necrosis of the cortex, with raised periosteum and dep-

osition of new bone. The appearance may suggest an osteogenic sarcoma or Ewing's tumor. The roentgenographic picture may change rapidly.

Pathologically the lesion consists of myxomatous-appearing tissue. Where the calcified periosteal layer is raised, it is separated from the bone by a substance of gelatinous appearance. The microscopic section resembles syphilis with round-cell infiltration, many plasma cells, and perivascular cuffing, but there is little endothelial reaction in the blood vessels.

The tendons frequently show ganglia of the same type of tissue that is present in the bone lesions. The joints may show similar growths on the synovia, which are painless and do not seem to attack the cartilage.

The response to arsenicals is dramatic, with roentgen evidence of consolidation in about six weeks.

Reproductions of photographs and roentgenograms are included. JOHN B. MCANENY, M.D.

Chronic Sclerosing Osteitis (Sclerosing Non-Suppurative Osteomyelitis of Garré). The Differential Diagnosis from Syphilitic Lesions of Bone, Sclerosing Osteogenic Sarcoma, Paget's Disease of Bone (Osteitis Deformans), Subperiosteal Ossifying Hematoma, Osteitis Fibrosa Cystica, Hemangio-Endothelioma (Ewing's Sarcoma, Endotheliomyeloma), and Metastatic Carcinoma. Henry W. Meyerding. S. Clin. North America **24:** 762–779, August 1944.

Chronic sclerosing osteitis is recognized as a form of osteomyelitis. Clinically it is characterized by persistent sharp pain and enlargement of bone. Roentgenologically it shows dense sclerosis usually occurring in the shaft of the tibia or the femur. The roentgenologist and the orthopedic surgeon experienced in diseases of bone usually are able to make a diagnosis from the clinical and roentgen findings. When doubt as to the true nature of the lesion exists, biopsy and a roentgenogram of the thorax (the latter to rule out possible malignant metastases) are indicated.

The differentiation of chronic sclerosing osteitis from syphilitic lesions of bone, sclerosing osteogenic sarcoma, Paget's disease of bone (osteitis deformans), subperiosteal ossifying hematoma, osteitis fibrosa cystica, hemangio-endothelioma (Ewing's sarcoma, endotheliomyeloma), and metastatic carcinoma is discussed. A case of each of the various conditions is reported and illustrated with roentgenograms.

Simple Roentgenographic Method for the Measurement of Bone Length. A Modification of Millwee's Method of Slit Scanography. Gerald G. Gill. J. Bone & Joint Surg. **26:** 767–769, October 1944.

In order to measure the length of bones accurately, the author has applied a modification of Millwee's slit scanography. The equipment includes a lead plate with a 2-mm. slit across it, that will fit the cone slot in the ordinary radiographic tube holder. A rope is tied to the movable tube stand and through a pulley. A weight is fastened to the other end. The fall of the weight moves the tube stand at an accelerated rate, so that with a constant exposure the thicker part of the bone should be radiographed first and progression made toward the thinner portion. By variation of the radiographic factors, films of good quality can be obtained, and the length of bones can be accurately determined. There is, however, slight distortion of their transverse axes. JOHN B. MCANENY, M.D.

Collapse of Intervertebral Disc Following Spinal Puncture: Report of Two Cases. F. Harold Downing. U. S. Nav. M. Bull. **43:** 666–673, October 1944.

Two cases showing clinical and radiologic evidence of collapse of the intervertebral disk between L 3 and L 4 following spinal anesthesia are described. The theoretical explanation of such an accident is that the spinal puncture needle is inserted to one side of the mid-line so that it reflects the dura rather than penetrating it. The needle is then forced forward through the annulus fibrosus lateral to its reinforcement by the posterior longitudinal ligament. Since no spinal fluid is obtained, the maneuver may be repeated several times with multiple punctures of the annulus. The nuclear material may escape immediately or the disk may be so injured that it later degenerates and collapses. The author's cases illustrate both possibilities.

To prevent such accidents, it is suggested that a sharp, fine-caliber, short-bevel needle be used and that it be angulated cephalad on insertion so that, if it is inserted too deeply, it will strike the body of the superior vertebra rather than the intervertebral space.

BERNARD S. KALAYJIAN, M.D.

Triphalangeal Bifid Thumb: Report of Six Cases. Paul W. Lapidus and Frank P. Guidotti. Arch. Surg. **49:** 228–234, October 1944.

The authors report six cases of bifid triphalangeal thumb of varying degrees of development, in two instances hereditary. It is their belief that the extra phalanx represents an abortive stage of polydactyly, or longitudinal splitting of the segment, with assimilation of the extra digit as a single segment of phalanx, rather than a reversion. A schematic system of the various stages from normal to complete longitudinal splitting is presented in the form of a diagram. Photographs and roentgenograms illustrating the six case reports are supplemented by others showing various degrees of bifidism of the digital rays of the extremities. Among these is an interesting film of the feet showing complete splitting of the left second, third, and fourth segments, with the result that the foot had eight complete toes and metatarsals. LEWIS G. JACOBS, M.D.

Causes of Failure in the Treatment of Congenital Dislocation of the Hip. Ignacio Ponseti. J. Bone & Joint Surg. **26:** 775–792, October 1944.

Several types of congenital hip dislocation occur: (1) embryonic dislocation, in which the head develops outside of the acetabulum; (2) fetal dislocation occurring during the fetal period; (3) natal dislocation, originating during delivery; (4) postnatal dislocation, the most common type, due probably to some congenital dysplastic condition; (5) subluxation, with a shallow acetabulum and upward displacement of the femoral head but without complete dislocation. The author has used a slightly simpler classification, grouping his cases, 129 in number, merely as prenatal, postnatal, and doubtful.

Determination of the type of dislocation is of importance for both prognosis and treatment, and for this purpose an adequate x-ray examination is of the first importance. In interpretation of the roentgen films it is to be borne in mind that at birth the acetabulum is mostly cartilage. Normally its roof is represented by a dense, slightly concave line, which is the lower border of the ossification center of the ilium.

After the first year, a lighter line appears near the roof, representing the spread of ossification through the anterior or posterior acetabular wall.

In prenatal dislocations, since the head of the femur does not develop in the acetabulum, the acetabular roof is not concave but is flat or convex, and the lighter shadows representing the anterior and posterior walls fail to appear at the end of the first year. The ossification center for the femoral head appears late. A secondary acetabulum is usually well developed after the age of one year, located above the normal one and having no connection with it. Twelve of the author's cases were of the prenatal type.

Postnatal dislocation occurred in 87 of the author's cases. In this group a predislocation stage is usually present at birth, consisting in obliquity of the acetabular roof, delay in appearance of the nucleus of the femoral head, and ectopy of the femoral epiphysis. During this stage the head is still in the acetabulum and may develop normally. Dislocation, if it occurs, takes place slowly and progressively during the entire first year, being well established when the patient begins to walk. The head of the femur slides progressively upward and backward over the surface of the acetabular roof and over the lateral aspect of the iliac wing. In posterior dislocations the roentgenogram shows what the author calls "bilabiation," which appears on the film as an opening of the lateral margin of the ossified acetabular roof for the passage of the femoral head. In anterior and upward dislocations this sign may be absent. In some instances the head of the femur does not pass above the level of the labrum glenoidale, in which case only a subluxation occurs. With complete dislocation a secondary acetabulum develops as an upward prolongation of the primary acetabulum.

The so-called U-shaped shadow formed by the inner and outer surfaces of the medial wall of the acetabulum below the Y cartilage is widened in postnatal dislocations and absent in prenatal dislocations.

Twenty-nine of the author's cases were classified as doubtful, *i.e.*, they could not be placed with certainty in either the prenatal or postnatal group. In these cases the secondary acetabulum was usually well formed and completely separated from the primary acetabulum, while the bilabiation sign was absent.

The significance of the classification of congenital dislocations of the hip is obvious from the results in this series. In none of the 17 cases of prenatal dislocation treated was a normal hip obtained, from which it may be concluded that such dislocations should not be reduced unless the patient is seen during the first months of life. If these cases are left alone a secondary acetabulum will develop which will provide a good functional result. In the postnatal and doubtful cases reduction is indicated. The chief causes of failure in these cases, as determined in this series, were epiphysitis of the femoral head, a tendency to subluxation at the beginning of walking exercises, and osteosclerosis of the acetabular roof. Modifications of treatment to insure better results are outlined.

JOHN B. MCANENY, M.D.

Degenerative Calcification in Articular Cartilage of the Knee. Paul H. Harmon. J. Bone & Joint Surg. **26:** 838–840, October 1944.

Two cases of calcification of the articular cartilage of the knee joint are reported.

The first patient was a 75-year-old man who fell, injuring his left leg. A roentgenogram of the knee showed a narrow intra-articular zone of calcification which followed the contour of the articular cortex of the femoral condyles into the recesses of the joint. Death occurred from a urinary tract infection, and sections from the knee joint showed diffuse calcification of the articular cartilage. The menisci were only slightly calcified.

The second patient, a man of 55, was examined for an acute attack of gout, when the articular calcification was incidentally discovered. Linear zones of calcification were demonstrable in both knees and both wrists. Re-examination after two years showed extension of the calcifying process.

This condition is to be distinguished from calcification of the menisci, which is believed to be more common. JOHN B. MCANENY, M.D.

Congenital Talonavicular Synostosis. Harold B. Boyd. J. Bone & Joint Surg. **26:** 682–686, October 1944.

This is a report of 4 cases of congenital talonavicular synostosis, which is rather rare but probably of little clinical importance in itself. However, there is usually an enlargement at the distal end of the navicular on the medial aspect of the foot, which may interfere with the fit of a shoe and become painful. The projection can be removed without difficulty and with resulting comfort to the patient.

The author refers to the review of this subject by O'Donoghue and Sell (J. Bone & Joint Surg. **25:** 925, 1943. Abst. in Radiology **42:** 517, 1944).

JOHN B. MCANENY, M.D.

Osteoid Osteoma of Mid-Shaft Region of Femur. Case Report. Paul H. Harmon. Am. J. Surg. **66:** 128–131, October 1944.

A case of osteoid osteoma, a non-suppurative, localized benign tumor process composed of osteoid tissue occurring in bones, is described. A 9-year-old girl had experienced intermittent pain in the mid-portion of the right thigh for ten months. Examination showed no positive findings except a fusiform enlargement, definitely palpable, at this site. X-ray studies revealed an area of sclerosis, which appeared as a thickening of the cortical shadow encroaching upon the marrow space. In the center of this thickened sclerotic area in the bone was a radiolucent area approximately 2 cm. in diameter. The roentgen diagnosis was "infection with abscess formation." Curettage was performed and several drill holes were placed through the neighboring reactive bone. The patient made an uneventful recovery and had remained normal for eighteen months following the operation. This case represents the most characteristic site of occurrence of osteoid osteoma, *i.e.*, in the mid-shaft region of a long bone.

Radiographic Examination of the Ankle Joint Including Arthrography. F. R. Berridge and J. G. Bonnin. Surg., Gynec. & Obst. **79:** 383–389, October 1944.

Certain groups of ankle joint injuries require special forms of examination to demonstrate damage to the ligaments. The authors employ, in addition to the usual views: (1) plain radiography in a standard position of both the injured and opposite sides, for comparison; (2) roentgenography under strain, *i.e.*, in the so-called

"position of deformity," with comparable examination of the opposite ankle; (3) arthrography with a contrast medium injected into the ankle joint.

Four positions are recommended for roentgenographic study of the ankle, to be used according to indications in the individual case: (1) anteroposterior, with 10 degrees internal rotation; (2) anteroposterior, with 30 degrees internal rotation, obtained by use of a wooden prism, the head of the first metatarsal and the medial malleolus resting against the prism, with the foot in dorsiflexion; (3) lateral, through both malleoli; (4) lateral with rotation to throw the fibula behind the tibia. For the anteroposterior views the knee should always be in a true anteroposterior position.

The second of the positions listed above, in 30 degrees inversion, is the best to show diastasis of the tibiofibular syndesmosis. This is supplemented by films with the foot externally rotated and dorsiflexed and, in some instances, by arthrography. The authors do not agree with the view held by some that a clear space between the tibia and fibula is indicative of diastasis. They have on several occasions seen such a space at the syndesmosis on either side and attribute it to a shallow tibiofibular groove.

Radiography under strain has proved the most useful method of investigation. It is carried out with the patient under pentothal anesthesia. Since 5 per cent of normal people show relaxation of the fibular collateral ligament, allowing rotation of the talus on inversion of the foot, comparable films of both ankles are necessary when the position of inversion is used. Views under strain are made as follows: (1) inversion, to show rotation of the talus, which may range from 5 to over 45 degrees depending on which ligaments are torn; (2) eversion to show rupture of the deltoid ligament, which results in rotation of the talus in ranges from 10 to 45 degrees depending on the completeness of the lesion; (3) lateral view in plantar flexion, which shows separation of the talus and tibia if both collateral ligaments are torn; (4) anteroposterior projection in 30 degrees inversion with external rotation of the foot, to distinguish between sprains and complete ligamentous rupture.

For arthrography the authors use 3 to 6 c.c. of diodone, such as is used in intravenous urography, injecting it while the patient is still under the anesthetic used for the strain views. The injection is made anteriorly if possible and the joint manipulated to diffuse the medium through the cavity. The usefulness of this technic is limited, but it will demonstrate partial diastasis which the other methods fail to show and it can be used to distinguish between old and recent lesions.

J. L. BOYER, M.D.

Fractures about the Elbow in Children. Harold B. Boyd and A. Ralph Altenberg. Arch. Surg. **49:** 213-222, October 1944.

Supracondylar fractures are the most common fractures about the elbow in children. They constituted about 65 per cent of the authors' series of 713 elbow fractures in patients under twelve years. Even this is considered too low a percentage, as many cases of this type are not hospitalized. The diagnosis can usually be made clinically but should be confirmed roentgenographically, in order to rule out condylar fractures, which demand a different form of treatment. Supracondylar fractures can usually be successfully treated by closed manipulation. The actual fracture is often less serious than the concomitant damage to nerves and blood vessels. Volkmann's contracture is a serious complication, which should be prevented by careful observation of the circulation at frequent intervals, with release of any constriction.

Condylar fractures are fairly common, constituting 25 per cent of this series. They should be treated by immediate open reduction and internal fixation. If this is not done, an overgrowth of the uninjured condyle produces, later in life, either a valgus or varus deformity, a so-called traumatic arthrosis.

Fractures of the neck of the radius in children (5% of this series) should be treated conservatively if the head of the radius is in good position; by operative reduction if the position is bad. The radial head should never be removed in a child.

Fracture of the ulna with concomitant dislocation of the radial head (*Monteggia fracture*) constituted 2 per cent of this series; in all fractures of the ulna roentgenographic study of the elbow should be made to rule out this type of injury. In most instances the ulnar angulation can be neglected, as subsequent growth will smooth it out, but accurate reduction of the radial head is important and can usually be secured by closed manipulation. If the dislocation recurs, operative repair with a fascial loop is indicated, and in this case internal fixation of the ulna is indicated.

Fractures of the olecranon (1.5 per cent) and *T-fractures of the lower humerus* (0.8 per cent) are rare in children; they usually require open reduction.

LEWIS G. JACOBS, M.D.

Fatigue-Stress Fractures, Diverse Anatomic Location and Similarity to Malignant Lesions. J. Gershon-Cohen and Robert E. Doran. U. S. Nav. M. Bull. **43:** 674-684, October 1944.

The authors prefer the name "fatigue-stress fracture" for those fractures which follow repeated minor traumatization or over-stressing as in marching. They believe the fractures are similar to those which occur in metals following exhaustion from overloading. The fractures occur far more commonly in the metatarsals than in other bones. Of the metatarsals, the longer second and third often bear an unusual proportion of the stress and are most commonly fractured. Other bones occasionally involved are the tibia, femur, fibula, calcaneus, pelvic bones, humerus, ulna, and spine. The ribs may show similar fractures when cough is present. These fractures occur most commonly, but not invariably, during young adult life.

The extent of fragment separation depends upon the amount of muscle pull. The authors grade the fractures on the degree of distraction of the fragments. Their grade I fractures correspond to what has previously been described as a "march fracture" of the ordinary type. Grades II and III occur under similar circumstances but show many of the characteristics of routine traumatic fractures with immediate production of symptoms and demonstrable fracture lines.

These fractures must be differentiated from spontaneous pathological fractures. Pathologic fractures are usually not related to exercise, are often painless, show a clear broad fracture line and little early callus formation, are frequently multiple, are surrounded by diseased bone, are not limited to weight-bearing bones, and are likely to be associated with systemic disease. Fatigue-stress fractures occur with pain during or

following exercise; callus formation is a prominent characteristic; the fracture line is often ill-defined; the fractures are usually single and involve weight-bearing bones in healthy persons.

BERNARD S. KALAYJIAN, M.D.

March Fracture. A Report of 307 Cases and a New Method of Treatment. Abraham Bernstein and Joseph R. Stone. J. Bone & Joint Surg. **26:** 743–750, October 1944.

This contribution is noteworthy because of the method of treatment that is offered. It consists in the insertion of a metal strip, 1/8 inch thick, 1/2 to 5/8 inch wide, and 6 inches long, beneath the sole of the shoe. The strip is countersunk in the leather and held in place by rivets. A few days are required for the patient to become accustomed to wearing the rigid-soled shoe, but he is soon able to carry on without difficulty, and soldiers can return to their severe training.

The advantage of this treatment is the continued use of the foot. Physiotherapy and hospitalization are unnecessary. After about eight weeks the patient is fully recovered. JOHN B. MCANENY, M.D.

March Fracture. Statistical Study of 47 Patients. Darrell G. Leavitt and Harry W. Woodward. J. Bone & Joint Surg. **26:** 733–742, October 1944.

This is a detailed statistical study of 47 march fractures, showing that the most likely cause is too rapid advance to peak military training before the feet have had sufficient time to become accustomed to the strain. Treatment consists in complete rest for two weeks, after which a plaster cast is applied. Physiotherapy follows and weight-bearing is not permitted until soreness has disappeared. JOHN B. MCANENY, M.D.

Insufficiency Fracture of the Calcaneus Similar to March Fracture of the Metatarsal. Clarence W. Hullinger. J. Bone & Joint Surg. **26:** 751–757, October 1944.

The author reports 53 cases of insufficiency fracture of the calcaneus, in some instances bilateral. These fractures occurred in soldiers in rigid training, most frequently after a cross-country run.

The patient complains of gradually increasing pain in one or both heels for a week or two. Examination shows swelling over the medial and lateral surfaces of the calcaneus, frequently obliterating the malleoli. The swelling disappears after one or two weeks' rest in bed but may recur. Walking is painful, but less so when done on the toes. There is tenderness on pressure over the calcaneus.

Roentgenograms fail to show the fracture until the fifth to eighth week, when an irregular sclerotic line of callus a few millimeters wide is seen extending incompletely through the bone, transverse to the long axis, indicating healing. The diagnosis is made on the clinical findings, since the x-ray evidence is so long delayed. JOHN B. MCANENY, M.D.

GYNECOLOGY AND OBSTETRICS

An Antepartum Study of Fetal Polarity and Rotation. Abner I. Weisman. Am. J. Obst. & Gynec. **48:** 550–552, October 1944.

This author presents a review of radiographic antepartum studies of 100 unselected primiparous women. Roentgenograms of the fetus were taken as early as radiopaque shadows could be detected and at regular intervals during gestation. Films made at approximately five months showed 74 cephalic presentations and 26 errors in polarity. At eight months, 19 of the 26 fetuses formerly showing faulty presentation had rotated spontaneously to the cephalic presentation. Six of the remaining 7 were manually rotated by external version. The remaining one was allowed to go to term in breech presentation and delivered by section because of a fibroid blocking the cervix. All the others were delivered normally with the vertex presenting.

The author concludes that repeated radiologic studies are advantageous during the course of pregnancy; that 73 per cent of the errors of polarity will correct themselves by the eighth month; if spontaneous correction has not occurred by the eighth month, it is unlikely to occur after that and external version is often indicated.

HOWARD GUARE, M.D.

THE GENITO-URINARY TRACT

Duplication of the Renal Pelvis and Ureter. Laurence F. Greene. S. Clin. North America. **24:** 910–921, August 1944.

Duplication of the renal pelvis and ureter is a congenital anomaly in which one kidney is supplied with two pelves and two ureters. The condition may be bilateral. The duplication of the ureter may be complete so that two ureters and two ureteral orifices are present, or incomplete, with one ureter joining the other and with but one ureteral orifice.

A diagnosis of duplication of the pelvis and ureter can usually be made with ease by excretory urography. A roentgenogram made preliminary to the injection of the contrast medium frequently will disclose elongation of the renal outline. After injection, a film will show the duplication. The diagnosis may be corroborated, or arrived at independently, by cystoscopy. Catheterization of each ureter and retrograde pyelography will further establish the diagnosis. Unfortunately, however, these methods are not infallible. Visualization of the renal outline and that of the duplicated pelvis and ureter may be obscured by gas in the bowel or, if a portion of the kidney drained by one of the pelves is diseased, the excretion of contrast medium by that segment may not be sufficient to cast a shadow, with the result that only that pelvis which drains the normal renal segment will be visualized. In this event, an intimation of duplication may be gained from a study of the shape, size, and position of the visualized pelvis. If only the upper pelvis is seen, it usually appears small, with only two major calices; less frequently a single major calix is present, and more rarely three major calices. If only the lower pelvis is visualized, duplication may be suggested by the position of the upper calix, which often, though not invariably, extends chiefly laterally and only somewhat superiorly.

Comparison of the size and position of the visualized renal pelvis with the renal outline may also suggest duplication. The visualized pelvis appears small as compared with the total renal mass and will appear to be situated in either the upper or the lower pole of the kidney. Thus, if the function of the upper segment of the kidney is poor, only the lower pelvis, draining the lower segment, will be visualized by excretory urography. Considerable renal parenchyma with no pelvic outlet

will be noted above the visualized lower pelvis. The converse is true if the lower segment of the kidney is functioning poorly. Cystoscopic examination may disclose but one ureteral orifice on each side. The second ureteral orifice may be overlooked; its appearance may be obscured, as by a ureterocele; or it may be in an ectopic position.

Three cases of duplication of the renal pelvis and ureter in which diagnostic errors were made are presented. Roentgenograms are reproduced.

Studies Concerning Effects of Calcium on the Urinary Tract. Harry R. Trattner and Bernard J. Walzak. J. Urol. **52:** 357–373, October 1944.

The authors studied the effects following intravenous injection of 10 c.c. of a 10 per cent solution of calcium gluconate on the musculature of the renal pelvis and calices, ureter, and bladder in 282 patients. With the aid of a whistle-tip catheter connected to a hydrophoragraph—a recording instrument—it was found that peristaltic waves were either considerably reduced in strength or disappeared, and the ureter relaxed to a degree considered to be one of clinical effectiveness in 27 per cent of 45 patients examined following intravenous calcium administration. Bilateral retrograde pyelography showed that injected calcium failed to alter spastic states of the renal pelvis and calices in 17 per cent, of the ureter in 41 per cent, and of the bladder in 30 per cent. Among 20 patients having ureteral colic, pain persisted in 30 per cent.

Excluding instances of slight to moderate relaxation, the injected calcium was found to produce marked relaxation, overcoming a previously existing spastic state, in 30 per cent of the renal pelves and calices, in 27 per cent of the ureters, and in 57 per cent of the bladders. In 40 per cent of 20 patients suffering from renal or ureteral colic due to stone, there was immediate and complete relief of pain.

From bladder filling determinations before and after calcium injections, it was found that the optimal range of urinary *p*H in which injected calcium is more apt to produce relaxation lies between 5.0 and 6.5, while increased bladder tone or spasm took place to a greater extent and with more frequency on the alkaline side. The more alkaline the urine, the more likely was this reversal of action to occur.

It was found, also, (1) that urine from the bladder and the right and left sides of the upper urinary tract may be of the same or a different *p*H; (2) that urine from the painful or infected side of the upper urinary tract was often alkaline; (3) that, excluding such conditions as alkaline cystitis, the *p*H of bladder urine was sometimes lower than that of urine from the upper urinary tract. When, in the presence of an acid reaction of the bladder urine, the administration of calcium is ineffective for the relief of pain or spasm involving the upper urinary tract, one should bear in mind the possibility that urine issuing from one or both kidneys may be alkaline. DAVID KIRSH, M.D.

Rectourinary Fistula. Seymour F. Wilhelm. Surg., Gynec. & Obst. **79:** 427–433, October 1944.

This report concerns 18 cases of rectourinary fistula (only one of them in a female). The fistula was due to trauma in 8 cases, to a neoplasm in 6, and to inflammation in 4. It is worthy of note that in every instance the trauma was surgical.

Symptoms consisted in the passage of gas and fecal matter with the urine or the presence of urine in the rectum Cystitis was usual, unless a check valve existed to prevent passage of feces into the bladder Diagnosis, aside from physical examination, proctoscopy, and cystoscopy, included the use of colored dyes or radiopaque media for injection The latter, used with fluoroscopy and radiography, gave valuable aid.

Treatment of the acute cases was by medical means and rest, followed by surgery when needed. The chronic cases were treated surgically in the majority of instances EDWIN L. LAME, M.D.

Retention of Urine in Children Due to Extravesical Pelvic Disease: Report of Two Cases. Charles P. Howze and Dorothy S. Jaeger. J. Urol. **52:** 319–325, October 1944.

The authors review the literature and report two cases of urinary retention due to extravesical pelvic disease.

The first patient, a white male child of 3 1/2 years, was admitted to the hospital with abdominal pain of two days' duration. After study, he was discharged with a diagnosis of mesenteric lymphadenitis. Four and a half months later, he was readmitted with urinary retention. A urogram showed bilateral hydronephrosis, and rectal palpation revealed a firm mass filling the lower pelvis. At operation a chronic appendiceal abscess was discovered and removed. Urinary function was restored and recovery was uneventful.

The second patient was a 4-month-old girl, who had been unable to void for the past nine days, requiring catheterization. Three months earlier a number of sacrococcygeal cysts, one of which filled the posterior half of the pelvic cavity, had been removed, but no evidence of malignant growth was seen microscopically. Rectal examination now disclosed a cystic mass the size of a small orange, posterior to the rectum. A urogram showed bilateral hydronephrosis. Seventeen days after admission, an exploratory operation was performed, and a sacrococcygeal cyst covered by posterior pelvic peritoneum was removed. Convalescence was uneventful and postoperative urograms showed a normal upper urinary tract. Pathologically, the mass removed was believed to be a "mixed tumor of spina bifida arising in and separated from the point of origin in the central nervous system at an early stage of embryonic development." N. P. SALNER, M.D.

THE SPINAL CORD

Pain Produced by Intraspinal Tumor Simulating Pain Caused by Gallbladder Disease. Report of a Case. William A. Black. S. Clin. North America **24:** 893–902, August 1944.

Pain may be the only symptom of early tumor of the spinal cord. It may be confined to the spinal column but more often than not is projected along a nerve root to a localized region of the thorax, abdomen, or extremities. Craig (J. A. M. A. **107:** 184, July 18, 1936) states that in 80 per cent of spinal cord tumors pain is the initial symptom and that on an average it is two or more years before signs of compression of the cord appear. In one series of 312 cases, 10 per cent of the patients had been subjected to operation with the hope of relieving pain. A case is presented here in which the

symptoms masqueraded for three and a half years as those of gallbladder disease.

Intraspinal tumors are of two types: extramedullary, arising from the tissues around the spinal cord, and intramedullary, arising in the cord itself. The author's case is of the extramedullary type. The symptoms of extramedullary tumors are divided into three phases—involvement of nerve roots, beginning compression of the spinal cord, and extreme compression of the cord. Intramedullary tumors frequently do not produce pain and neurologic signs offer the first indication of their presence.

The outstanding symptom of involvement of nerve roots is pain. This is usually lancinating, may be constant or intermittent, and is aggravated by coughing, sneezing, straining, lifting, or any maneuver that increases intracranial pressure. With beginning compression of the cord, neurologic signs become evident, the location of the tumor in relation to the spinal cord determining their character. Severe compression of the cord produces paralysis below the level involved, loss of sensation, trophic disturbances, and loss of control of both vesical and rectal sphincters.

Since pain is a subjective complaint and must be evaluated, a comprehensive and detailed history is necessary in the diagnosis of intraspinal lesions. Seven points which must be considered in each complaint of pain are: situation, depth and projection taken together, frequency, duration, intensity, progress, and associated symptoms. General as well as neurologic examination is necessary, together with spinal puncture, Queckenstedt studies, and roentgenography of the spinal column. Anteroposterior and lateral roentgenograms should be taken, with localized oblique and stereoscopic views of the region where there are clinical signs of tumor. Erosion of parts of the vertebrae due to pressure and invasion of the bone by tumor are sometimes demonstrated, but these changes were not discernible in the roentgenograms in the author's case. Further information, particularly the exact location of the tumor, may be obtained by roentgen studies after the introduction of radiopaque oil. Such studies led to the diagnosis in the case here recorded, and a degenerating neurofibroma was successfully removed. Intramedullary tumors can be identified by division of the oil into two currents, one on each side of the cord. Because the iodized oil may cause irritation of the meninges and produce a radiculitis, it should be used only when necessary and should be removed at the time of operation.

THE BLOOD VESSELS

Primary Axillary Vein Thrombosis: Report of a Case. Norman H. Bruce. U. S. Nav. M. Bull. **43:** 748–753, October 1944.

Primary axillary venous thrombosis occurs chiefly in young males performing heavy duties. A case is reported here to emphasize the importance of venospasm in the syndrome and the wisdom of directing treatment against this phase. The clinical picture usually consists in rapid swelling of the affected arm with some pain, brawny edema, cyanosis, and lowered local temperature. Rest, elevation, immobilization, and diathermy form the usual treatment, with surgical intervention only when these fail. Venography is helpful in determining the site and degree of obstruction. The mechanical obstruction is not the sole cause of the findings, as the vein is often ligated and a section removed in radical mastectomies without serious consequences.

The case here described was typical as to history and clinical findings. A venogram showed a complete block. The patient was treated by application of an elastic bandage and overhead suspension of the arm without improvement. At the end of one week he was given novocain injections in the paravertebral ganglia—stellate and first to fourth dorsal. Within eighteen hours the edema was gone, the color of the arm was normal, and the skin temperature was nearly normal. A venogram seventeen days later showed partial reestablishment of the lumen; another after an interval of eighteen days showed almost complete return to normal

BERNARD S. KALAYJIAN, M.D.

RADIOTHERAPY

NEOPLASMS

Treatment of Carcinoma of the Cervix During Pregnancy. Howard W. Jones, Jr., and William Neill, Jr. Am. J. Obst. & Gynec. **48:** 447–463, October 1944.

According to many writers the treatment of choice for cervical carcinoma in the pregnant woman is the emptying of the uterus and irradiation. Others, including the authors of this paper, believe that judicious use of radium may allow carrying the pregnancy to term without too great danger to the mother or the child. Of many reports on this subject, few show five-year end-results for the carcinomas or sufficiently long observation of the children—at least a three-year period—to determine the effects of irradiation.

The authors' study of the literature and 8 cases of their own shows that the chance for production of microcephaly by radium therapy during gestation does not exceed 20 per cent and may be as low as 6 per cent. Among their 8 cases there were 5 children alive and normal at three to fifteen years of age. There were 2 microcephalic children, one of whom died, at four years, of tuberculosis. The eighth child appeared normal but died of measles at eighteen months. There is little evidence in the literature as to the added risk to the mother in carrying pregnancy to term. The authors report 4 patients living and well five years and 1 three years, out of 7 treated during 8 pregnancies. The decision on the course to follow may be influenced by the desire of the parents for a child and their willingness to assume the risk of an abnormal baby.

Treatment started before the fifth month appears to be more hazardous for the fetus than irradiation later in pregnancy. High-voltage x-ray therapy is always contraindicated because of the danger of a substantial depth dose in the region of the developing child. Radium in the cervical canal is also dangerous for the fetus and may initiate labor. The authors use radium tubes held in a cloth plaque against the cervix, employing a large quantity—2.5 to 3 gm.—to shorten treatment time and thus reduce danger of abortion. Dosage must be determined by clinical experience. The dosages in the cases reported here ranged from 1,614 to 3,922

mc. hr. All the patients were delivered by cesarean section. Additional radium and x-ray therapy are given after delivery when indicated.

When carcinoma is discovered after the fetus is viable, cesarean section followed by radiation therapy is indicated. Hysterectomy at the time of section carries a high operative mortality and there is no evidence that it produces better results. Most of the cancers discovered during pregnancy are of Stages I and II. A Stage IV carcinoma usually indicates inadequate prenatal care. BERNARD S. KALAYJIAN, M.D.

Uterine Bleeding and the Roentgenologist. Joe V. Meigs. New England J. Med. **231:** 549–552, Oct. 19, 1944.

This is a plea for more intensive study of abnormal uterine bleeding before patients are subjected to pelvic irradiation or surgery. Many cases can be cured by proper medication or substitution therapy.

Among the causes of abnormal uterine bleeding, the author mentions changes in the chemical fractions of the blood, a calcium or prothrombin deficiency; blood dyscrasias, as the leukemias or thrombocytopenic purpura; injuries to the sympathetic nervous system; withdrawal of progesterone or estrin; ovarian tumors, more especially granulosa-cell tumors, thecomas, and some cysts; deficiencies of vitamins C, K, and even B; cervical and endometrial polyps and fibroids; pelvic inflammation; cancer of the cervix, endometrium, or fallopian tubes.

In metropathia haemorrhagica, representing the most frequent hormonal pattern of abnormal bleeding, the endometrium is hyperplastic and there is a follicle cyst of the ovary, with a wrinkling of the remainder of the organ and absence of corpus luteum. There may be normal or excessive bleeding, followed by continuous flowing; more frequently a period of amenorrhea precedes a prolonged flow. The condition is seen early or late in the menstrual life. Treatment is with progestin, the corpus luteum hormone.

Other types of hormonal dysfunction should be appropriately treated. Similarly, if the bleeding is attributable to a blood disease, lack of a normal component for coagulation, or a vitamin deficiency, treatment can be undertaken along proper lines. Other cases should be treated with the possibility of a malignant growth in mind, and tissue should be obtained from the cervix and endometrium for histologic study. In the author's opinion radiotherapy has a limited application, since he considers conservation of ovarian function to be most desirable. He especially warns against irradiation in women past the menopause, as this may check the bleeding due to a malignant neoplasm without halting the growth of the tumor, which may then be allowed to go on to an inoperable stage. In women of this group, a curettage should be done. If this fails to reveal the cause of the bleeding and there is a recurrence, the procedure may be repeated. With further recurrence it is best to remove the uterus. X-rays and radium should be reserved for the treatment of bleeding in spinsters near the menopause and for patients in too poor physical condition for operation. Fibroids and benign tumors should be treated by removal of the uterus and cervix with conservation of the ovaries. Cancer calls for surgery, irradiation, or both, according to the indications.

JOHN B. MCANENY, M.D.

A Rapid Radium Implantation Method for Rodent Ulcer. Alexander A. Charteris. Am. J. Roentgenol. **52:** 423–430, October 1944.

In a previous article (Am. J. Roentgenol. **44:** 737, 1940) a method of radium implantation for the treatment of basal-cell carcinoma in the vicinity of the eye was described. The results have continued to be satisfactory, with a high percentage of cures and a low incidence of eye damage. The present report describes a modification of the method whereby the treatment time is compressed into thirty hours, with even better cosmetic results. The needles used have a total length of 15 mm. (5 mm. active length), 0.6 mm. platinum walls, and a radium content of 2 mg. (element). The basic arrangement of implantation is a rectangle 2.5 by 1.0 cm., using six needles. Implantation is carried out as nearly as possible 0.5 cm. below the skin. During treatment the eye is not bandaged and acriflavine drops (1:1000) are used freely. The skin dose is approximately 3,000 r in thirty hours.

For lesions of the upper lid a thick contact glass is used. This raises the lid almost 0.5 cm. above the globe, thereby reducing the radiation incident on the globe some 50 per cent. In the 5 cases treated thus far, no eye damage has resulted.

A total of 62 patients of all types have been treated since May 1939. There have been only three failures.

L. W. PAUL, M.D.

NON-NEOPLASTIC CONDITIONS

Alpha Rays in the Treatment of Wounds. Erich M Uhlmann. Surg., Gynec. & Obst. **79:** 412–418, October 1944.

Radon gas can be readily incorporated in fatty solvents, and in the form of an ointment can be brought into close contact with lesions on the skin surface. Due to the extremely short range of the emitted alpha rays, this form of therapy obviously cannot be applied to malignant tumors.

For the last fifteen years, radon absorbed in neutral fat has been used successfully in treatment of skin changes resulting from destructive doses of radium and x-rays (see RADIOLOGY **38:** 445, 1942). The author believes that this apparent contradiction is explained by the fact that alpha rays are corpuscular, whereas x-rays and gamma rays are not. More recently, other types of skin lesions characterized by incompetent blood supply have been treated by this method, with equal success. These include Buerger's disease, varicose ulcers, diabetic gangrene, and ordinary burns. Histologic control studies reveal formation of new capillaries about the lesion.

Eight cases are presented. In 4, recurrent skin carcinoma was excised surgically in areas previously injured by irradiation, and healing did not occur until a course of therapy with radon ointment had been instituted. In the remaining 4 cases, there was delayed healing after radical mastectomy and after skin grafting for varicose ulcers. One patient had arteriosclerotic ulcers of the foot not treated by surgery. In every case, healing occurred at an accelerated rate following the application of radon ointment, and the resulting scars are described as remarkably soft and pliable.

The author emphasizes the simplicity of the method and its applicability by any physician who has familiarized himself with it. JOSEPH SELMAN, M.D.

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AUTHORS AND SUBJECTS

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